NOV 27 1939

Printed on thin paper for overseas circulation.

The Engineer

VOL. CLXVIII.—No. 4374 28, ESSEX ST., STRAND, LONDON, W.C. 2 NOVEMBER 10, 1939

Established 1856 Price One Shilling, by Inland Post 1s. 3d. Registered as a Newspaper

Engineering Library

We were already well established when we introduced this design—a big step forward from the bi-polar open type machine. The warning "Prices liable to be altered without notice" strikes quite a modern note!

JAN. 1901. NEW AND REVISED PRICES. (Liable to be altered without notice.)

NAT. TEL. No. 246. TEL. ADDRESS: "GOTHIC, NORWICH."

LAURENCE, SCOTT & CO., Ltd.

Established 1883. NORWICH, ENGLAND.

THE "NORWICH" 1900 TYPE FOUR-POLE ELECTRIC MOTORS.

"FORMER" WOUND ARMATURES.

WELL VENTILATED CORES.

PERFECT INSULATION OF WINDING AND COMMUTATION.

THOROUGHLY RELIABLE UP TO 550 VOLTS.

BRUSH GEAR EASILY ACCESSIBLE AND ADJUSTABLE IN EVERY WAY.

HIGHEST POSSIBLE EFFICIENCY.

HIGH PERMEABILITY STEEL MAGNET CORES.

FRAMES, etc., DESIGNED SO THAT THEY CAN BE SUPPLIED EITHER (1) Well Ventilated. (2) With Gauze Grids. (3) Totally Enclosed.

ALL PARTS ARE MADE TO JIGS AND INTERCHANGEABLE.

THE LUBRICATION IS AUTOMATIC AND OIL THROWING ABSOLUTELY CURED.

F.P. 30 & F.P. 38 SIZES.

The following are the principal features of the series of machines:—

The Commutator, Brush Gear and Connections are practically as handy and accessible as in open-type machines, and, as will be seen above, they are very well protected.

The Terminals are inside, and the mains enter through bushed holes, and the covers are provided with mica windows.

The Design of Frame, whilst it uses the metal in the magnetic circuit to the best advantage, gives very good ventilation, and an amount of protection to the armature and magnet coils which is ample in most cases. When more protection is required, the openings of any machine can be filled with grids holding wire gauze, or they can be completely filled in so that the motor is totally enclosed.

In all but the two smallest sizes, the frame is cast in two halves, so that the top can be lifted off to get at the armature.

Magnet Cores. These are of high permeability soft steel, and are circular in cross section. They are of considerably greater length than is usual. The coils are wound on separate formers with high conductivity copper, 100% of Matthiessen's Standard.

The Bracket and Bush, at the pulley end, are in halves in all sizes, so that the pulley or coupling has not to be taken off the spindle in order to take out the armature.

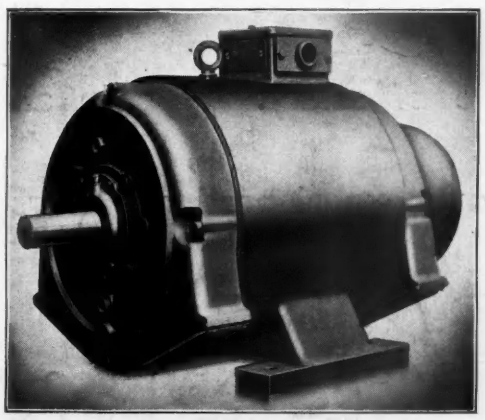
The Bearing Brackets can be slewed round, so that the feet of the machine can be fixed either to a vertical wall or to the ceiling.

(Description continued on page 4.)

(1)

We didn't stand still in 1900!

This reproduction from an old list shows that the South African War didn't cause us to stop all progress and development; from 1914 to 1918, too, we found time to make quite a few advances in the design of electric motors; and we have enough confidence to go ahead with our plans today.



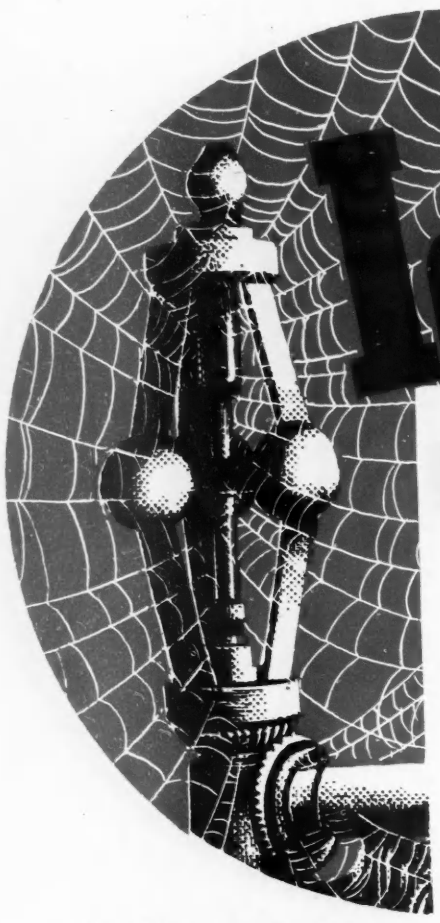
This is our latest industrial A.C. motor. Features include a very efficient ventilation system, improved protection, cartridge type bearings, more convenient terminal box, etc.

Two or three months ago we introduced an improved range of small and medium size A.C. motors. We are extending that improved range as fast as conditions permit and have other developments well in hand. When the war ends we expect to be in a very good position to meet your peace-time needs for electric motors for almost all industrial drives.

LAURENCE, SCOTT & ELECTROMOTORS LTD

ELECTRIC MOTOR MAKERS SINCE 1883

NORWICH: MANCHESTER: AUSTRALIA HOUSE, LONDON, W.C.2, AND BRANCHES



Idle Plant WON'T HELP THE COUNTRY!

If Britain's War Effort is to be exerted to the full all Plant must be put to the best possible use.

Have you any Plant surplus to your requirements which might be set to work in the National interests?
If so, write or telephone to our nearest office.

We have been approached by, literally, hundreds of firms who want Plant and Machinery for immediate delivery so that they can get ahead with urgent contracts, and it is our duty to satisfy them.

We will either purchase outright, or, if you prefer, negotiate the sale for you on a commission basis.

GEORGE COHEN SONS & CO. LTD.

Wood Lane, LONDON, W. 12	SHEpherds Bush 2070	Cobden Street, Pendelton, MANCHESTER	Pendelton 1376–8
Stanningley Works, Nr. LEEDS	Stanningley 71171	Princes Street, SOUTHAMPTON	Southampton 2963
191, Corporation Street, BIRMINGHAM, 4	Central 2751	Royal London House, Queen Charlotte St., BRISTOL	Bristol 20103
Coborn Works, Tinsley, SHEFFIELD	Attercliffe 42033.	Prince of Wales' Dock, SWANSEA	Swansea 2168–9
12, Grey Street, NEWCASTLE-ON-TYNE	Newcastle 23313	Sydenham Road, Queen's Quay, BELFAST	Belfast 57427
Cogan Street, Pollokshaws, GLASGOW	Langside 3041–2		

ESTABLISHED IN THE YEAR 1834

A.R.P. experts are agreed that the construction of steel-framed buildings with steel-strengthened basements is a sound proposition, having the advantages of convenience, speed and economy. ☆ Most important—the elimination of the risk of the main structure collapsing and the high powers of resistance of the steel strengthening provide a high degree of safety. ☆ In all matters of steel frame construction, let our experienced engineers guide you.

BANISTER WALTON & CO. LTD.

STRUCTURAL STEELWORK

RIVETTED · WELDED

MANCHESTER, 17, *Trafford Park.* *Trafford Park 2361* LONDON, S.W.1, *82 Victoria Street.* *Victoria 7846-7-8* LIVERPOOL, 2, *3 Brunswick Street.* *Central 1917* BIRMINGHAM, 15, *192 Broad Street.* *Midland 5934-5*

McN 3270

A Seven-Day Journal

Patents, Designs, Copyrights, and Trade Marks

STATEMENTS have appeared in certain newspapers, and have apparently been copied into German newspapers, to the effect that enemy-owned patents, designs, copyrights, and trade marks in this country are being confiscated or compulsorily transferred to non-enemies. No such action is, however, being taken. What is evidently referred to in these reports is the power given by the Patents, Designs, Copyright, and Trade Marks (Emergency) Act for the grant in proper cases, and under strictly regulated procedure, to persons who are not enemies or enemy subjects, of licences to work patented inventions, use registered designs, or produce or perform copyright works, belonging to enemies. The object of this legislation is to enable the articles or substances in question—which cannot now be made here or supplied to this country by the enemy proprietors concerned—to be produced here. The licences granted do not deprive the enemy-owner of his property in the patent, design, or copyright; and they will be made subject to proper conditions, including the payment of royalties to the Custodian of Enemy Property. So far as enemy-owned trade marks are concerned, it is only in the comparatively rare cases where it is difficult or impracticable to describe or refer to an article or substance without the use of an enemy-owned trade mark that power is given for the temporary suspension (not the confiscation) of the trade mark rights in individual cases in favour of a person who desires to deal in the article or substance, and to establish another description for it.

Metropolitan Water Board

THE thirty-third annual report of the Metropolitan Water Board for the year ended March 31st, 1939, states that the average daily flow of the Thames at Teddington for the year was 1,196·5 million gallons, a decrease of 113·2 million gallons on the previous year. This flow represented 9·23in. of rainfall from 3855 square miles of watershed, or 33 per cent. of the average general rainfall. Average daily extraction of water from the Thames amounted to 214·9 million gallons daily, an increase of 2·4 million gallons daily. The average daily flow of the River Lee was 93·5 million gallons, equivalent to a rainfall of 5·69in. on 414 square miles of watershed, or 22 per cent. of the general rainfall. An average daily abstraction of 22·4 million gallons from the upper reach at New Gauge, Hertford, and of 34·6 million gallons from the lower reach at Enfield Lock and Chingford is recorded. Daily abstraction was decreased by 8·9 million gallons. An average daily quantity of water of 51·66 million gallons, an increase of 1·60 million gallons, was drawn from natural springs, wells, and gravel water. The total amount of water delivered to the mains was 114,329·8 million gallons during the year, of which 139·8 million gallons was accounted for by bulk supplies. The population served was 7,073,700, representing a small increase of 3900. Daily average consumption works out at 43·85 gallons, an increase of 0·53 gallons. At the time of compiling the report the total capacity of the Board's reservoirs was 19,610·3 million gallons, equivalent to 62·61 days' supply on the basis of the year's consumption. During the year 100·86 miles of new mains were laid, and expenditure of £408,851 on protective measures against air raids was approved. New testing laboratories were completed at New River Head. No other single laboratory in the world, it is claimed, deals annually with so great a number of samples.

Australian Armaments

SOME details of Australia's proposed contribution to the war effort were announced by Mr. Menzies, the Prime Minister, on November 1st. Defence expenditure is now estimated at £59,500,000, and of that sum only £7,700,000 is to be spent abroad. This expenditure for a single financial year compares with £19,600,000 for the first year of the Great War. The Government has decided to build three destroyers of the Tribal class instead of the two originally announced, and the further expansion of the construction programme will be considered as building facilities improve. Ships, Mr. Menzies said, had been chartered for mine-sweeping and anti-submarine work, and merchant ships had been heavily armed for local defence and for attachment to the British Admiralty. Defensive guns had been placed on more than sixty ships, Navy personnel had been doubled—it now totalled 10,000 men—and all reserves had been called up. The decision had been taken to re-organise the Army on a mechanised basis, and there would be an immediate expenditure of £1,500,000 on more than 4000 motorised vehicles. Four more munition factories would be built. As recorded in another Journal note, the intention to send an Australian Expeditionary Air Force to Europe has been abandoned. But Mr. Menzies gave some particulars of the contribution of Australia to the Empire air scheme. Nineteen squadrons are to be formed by June of next year instead of twelve months later as originally announced. One hundred instead of fifty Lockheed Hudson aircraft are to be purchased in the United States, and several hundreds of light trainer aircraft will be purchased locally.

Joint Advisory Council

ON November 1st the Joint Advisory Council for Industry held its first meeting. This Council, of which the Minister of Labour and National Service is chairman, is composed of fifteen representatives drawn from the British Employers Confederation and the Trades Union Congress General Council. Its function is to consider and make representations to the Government on all matters in which employers and workers have common interest, and it is probable that it will deal with a wide variety of subjects, including the cost of living, the effects of the black-out on industrial working, the supply of labour in the proper quantity and quality to districts where it is needed, and any other matters directly or indirectly affecting production or the welfare of the men. Mr. Brown, Minister of Labour and National Service, presided at the first meeting, and subjects considered included the schedule of reserved occupations, the Control of Employment Act, the cost of living index figure, and the possibility of reducing the black-out period. It is probably a reasonable supposition that the recent announcement of a reduction of one hour in the black-out period has followed upon the representations of the Council. Upon the subject of the schedule of reserved occupations the Council decided to draw public attention to the fact that the schedule merely places certain restrictions upon enlistment or enrolment in the defence Services. Nothing in the schedule affects the freedom of any person to change his civil occupation. The next meeting of the Council will be held on December 6th.

Ministry of Supply

In a statement last Friday, November 3rd, Mr. Burgin, Minister of Supply, said that since the beginning of the war his Ministry had spent about £110 million in new commitments, and that not a day passed without an increase of the number of units in production. There were already as many as 10,000 factories engaged on direct orders not to mention those concerned with sub-contracts. Besides supplying the British Expeditionary Force, the Royal Navy, and the Royal Air Force, they hoped also to be of assistance to the Dominions and our Allies. There was close consultation with the Dominions and knowledge was being pooled. Behind the industrial framework of manufacture there was the collection from world-wide sources of raw materials to satisfy the needs of the three fighting services, civilian trade, and export trade. With regard to the effect of the removal of the American embargo on the export of arms, Mr. Burgin said it would be necessary to review our own production and indent upon America for such articles as would make good any gaps. We should probably ask for machine tools, some gun steel, and certain raw materials immediately, and ultimately perhaps ammunition. Since the outbreak of war we had ceased either to export or import machine tools. America could offer deliveries which compared favourably with those of any source of supply. The Ministry was on good terms with labour, and the Trades Union Congress had appointed ten representatives to work in an advisory capacity with the Ministry.

Contraband

DETAILS of goods intercepted by the Allies as contraband suspected to be destined for Germany were published at the end of last week, and prove to be of interest to manufacturers in this country. They provide a measure of the success of the blockade directed against Germany. Up to the end of the period under review, well over 500,000 tons of contraband had been intercepted and detained, the French official figures reaching 150,000 and the British over 400,000 tons. In the fortnight October 14th to 28th the British control intercepted 63,000 tons. Among goods detained in a typical recent fortnight were 7500 tons of copper, 3200 tons of zinc, 480 tons of lead, and 11,000 tons of lubricating oil. During the whole period since contraband control took effect 87,540 tons of petroleum products, including 12 million gallons of petrol, have been seized, and over 30,000 tons of oilseeds, oils, fats, and soya products essential for the production of nitro-glycerine were held up. Sulphur, pyrites, and chlorate of potash are raw materials for the manufacture of explosives, and 2500 tons, 5700 tons, and 1500 tons respectively were seized. In addition, 21,500 tons of aluminium and bauxite intended for Germany will not reach that country. Figures for other materials are of less direct interest to general engineering, but may be also mentioned. Jute, wool, cotton, and other fibres necessary for the manufacture of many things besides clothing were detained to the extent of 11,600 tons, whilst the figure for hides and skins is 2400 tons, and for various tanning materials 600 tons. The Ministry of Economic Warfare has the advantage of experience gained in the last war in the detection of contraband, and is fully aware of the many subterfuges which may be practised.

Ammunition Production

IN an official announcement last Monday some particulars were given of the manner in which industry is being organised to meet war needs. It was pointed out that war to-day is no longer a matter of men but of machines, and that the problem is not only to keep up war-time supplies but also so to arrange matters that industry can also supply civilian needs and carry on export trade. Even in this country where planning is unpopular it was possible before the war to survey the capacity of different firms for the production of war needs and, knowing the needs of the armed forces, to calculate the requirements of raw materials and to give firms manuals on how to carry out production and to plan for efficient production if need should arise. The extent of the change-over of industry to the production of war-time necessities is already very large. Gramophone and wireless manufacturers, for instance, have started to produce fuses, boxes, instruments, gauges, and shells; agricultural engineers, gun mountings, tanks, and shells; knitting machine makers, complex instruments, small arms components, and gun mountings. There is scarcely a firm whose normal equipment was wholly suitable for arms production without adaptation or the supply of extra machine tools. Special purpose machine tools have been so successfully designed that whereas on certain German plant in this country a particular shell can be turned out in 45 minutes, on modern British plant the time taken is only 35 minutes. This time covers more than thirty machine operations and work by hand in addition. Certain fuses are now stamped instead of being made from bar as in the last war, with a resultant saving of 20 per cent. in the material required. Cartridge cases require special plant not normally used in industry, but already 10 to 15 per cent. more per press is being produced than had been expected. In the last war, according to the official announcement "the position in this country in regard to instruments was terrible." But the optical glass made here now compares favourably with that from any other source. Plans made before the war included the provision of a good supply of machine tools, and the machine tool trade has planned to increase its output. The production of articles for normal civilian use is proceeding in many factories side by side with that of ammunition, and care has been taken to spread the load of war-time work so that small as well as big firms are taking their share in it.

Australian Air Plans

A CHANGE has occurred in Australian plans for taking part in the war. Originally it was intended that an Australian expeditionary air force should leave the country for Europe or any other place as needed. On October 31st, however, Mr. Menzies, the Prime Minister, announced that this scheme had been abandoned after consultation with the United Kingdom government. Some time ago nine Short-Sunderland flying boats were ordered in this country by Australia. Three are already in service and the remaining six are due for early completion. It was now proposed, said Mr. Menzies, to send 17 officers and 166 other ranks to Great Britain to man and maintain these craft, and thus to form an Australian reconaissance squadron. Apart from this activity it was now intended to concentrate Australian effort on the successful development of the Empire air training scheme, which is centred upon Canada, and upon the strengthening of the Royal Australian Air Force for the defence of Australia. Mr. Menzies also stated that a factory was to be established in Australia for the manufacture of large aircraft engines. A site for the factory was being selected, and engineers would be sent overseas almost at once to purchase such tools and other necessary equipment as were not available in Australia. This factory, we understand, is intended not only to meet the needs of the Royal Australian Air Force, but will also produce a surplus which will be available to help to supply Great Britain and the other Dominions.

L

The Bronx-Whitestone Suspension Bridge

No. I

THE Triborough Bridge Authority opened to traffic on April 29th of the current year a great suspension span across the East River at a site that is about 2½ miles westward of the point where that waterway meets Long Island Sound. This bridge connects the borough of The Bronx with the borough of Queens and forms, with its two new highways, another link in the splendid Belt Parkway System, now far advanced, of the city of Greater New York, and which, upon its completion in a few years, will directly serve the four major boroughs of the Metropolis.

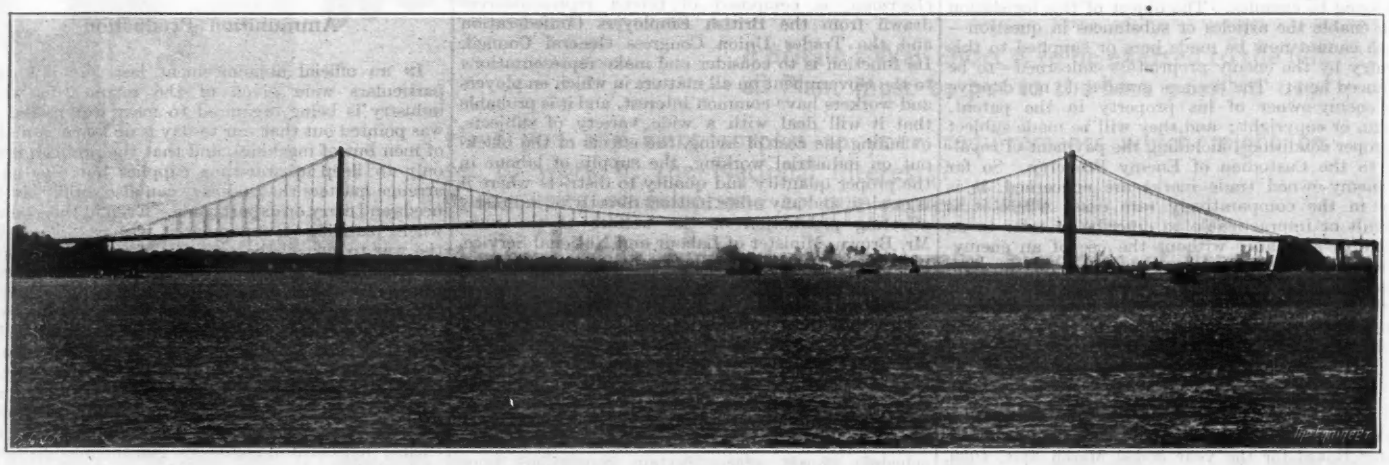
The Bronx-Whitestone bridge, with its two approach highways, has cost 17,785,000 dollars. The necessary funds for its construction were obtained by a sale of serial bonds totalling 18,000,000 dollars. The Triborough Bridge Authority readily disposed of those securities because of its success with its other toll crossing, the Triborough bridge, which interconnects the boroughs of Manhattan, The Bronx, and Queens.

After its opening the Bronx-Whitestone bridge soon became well-known as the most convenient route for motor traffic moving to and from the World's Fair and having its area of origin in interior eastern New York and the several states of New England; but in the future the bridge will have its greatest value as a means of readily reaching the southern and eastern parts of Long Island, from both the south and the north, without requiring traffic to pass through the somewhat densely developed central section of the borough of Queens. In brief, the crossing is another costly concession to the rapidly increasing volume of motor traffic and the insistent demand that long-distance motor vehicles be detoured well away from areas of congested local travel.

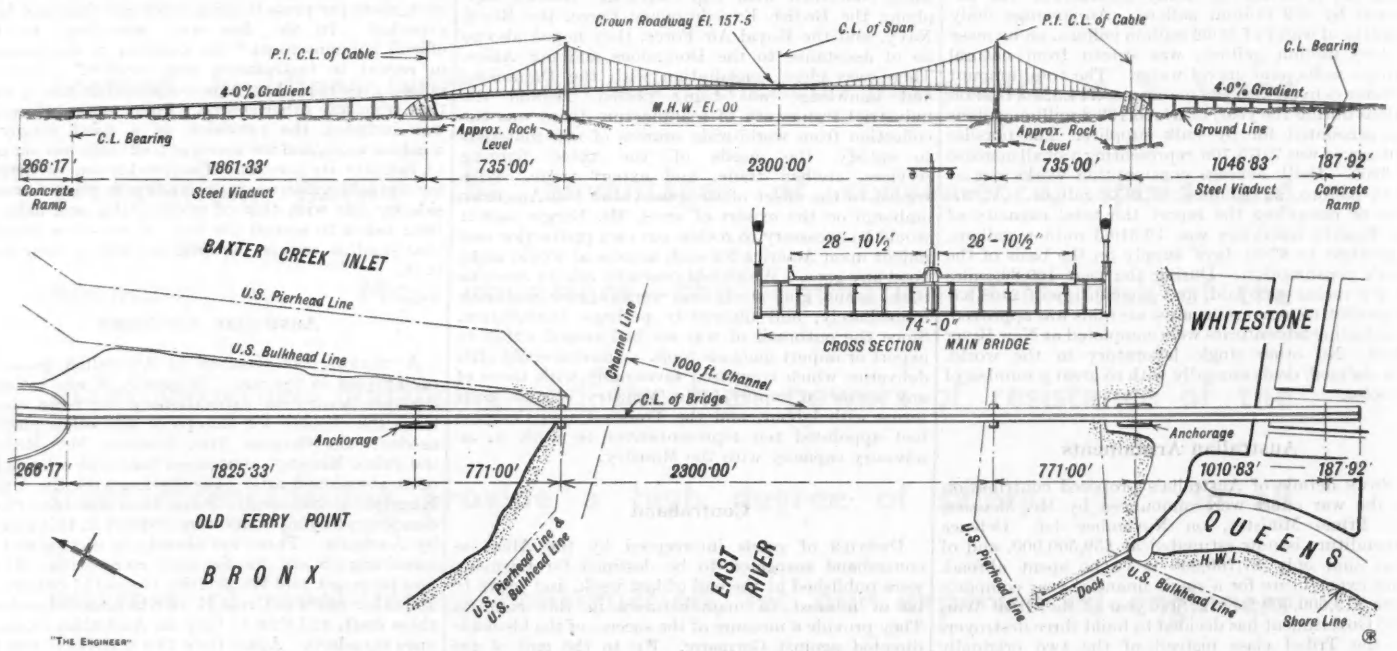
The Bronx-Whitestone bridge is something more than just another imposing structure, and it should be of much interest to engineers, inasmuch as it embodies various departures in design that emphasise how rapid in the last few years has been the advance in the art of the bridge builder. The designing of the structure was under the supervision of Mr. O. H. Ammann, director of engineering of the Port of New York Authority, who was ably assisted by other members of that organisation and by associate specialists called into service by the Triborough Bridge Authority. Mr. Ammann, as readers of THE ENGINEER are aware, has been intimately identified with the planning and building of numerous other big bridges, subaqueous vehicular tunnels, &c., in the United States; and in designing The Bronx-Whitestone crossing his desire was to produce a bridge of exceptional structural simplicity and incidentally keep the cost as low as possible while meeting every requirement as to strength, long life, and ease of maintenance.

The East River at the bridge site has a width of 3300ft. between the opposing shore lines, and that actual width is potentially reduced to 2250ft. by the interval between the pierhead lines prescribed by the War Department. Close to The Bronx shore line the bed rock of Manhattan schist is found about 100ft. below mean high-water datum, while on the Queens side of the river the same rock formation lies at a depth of approximately 160ft. below the same datum. In mid-stream bed rock is probably at a still lower level. The submerged rock carries an immediate overburden of glacial drift of varying thickness, and upon that is superposed a considerable blanket of silt that forms the water bed of the East River. The silt and the glacial drift made it impracticable to establish the foundations for the two tower piers at any elevation short of at least contact with solid rock.

After considering the existing physical conditions and the relative merits of different types of bridge structures, it was decided to make the crossing a suspended span and to place the two main towers near to the pierhead lines fixed by the Government engineers. A suspension bridge was found to offer the most economical solution of the problem. The Bronx-Whitestone Bridge has a center span 2300ft. in length, from center to center of the two main towers, and two side spans, each of which has a length of 735ft. between its respective tower and its contact with the anchorage on which its approach end rests. The bridge proper has an overall length, including the two cable anchorages, of about 4030ft. At mid-length the central span has an under clearance at mean high water of 148ft., plus or minus, and at the towers that span has an under clearance of approximately 130ft. at



COMPLETED BRONX-WHITESTONE BRIDGE



ELEVATION AND PLAN OF BRONX-WHITESTONE BRIDGE

As the crow flies, The Bronx-Whitestone bridge is situated a little more than 5 miles eastward of the Triborough suspension span across the East River. The Bronx-Whitestone bridge connects Old Ferry Point, in The Bronx, with the waterfront of Whitestone, in Queens. Old Ferry Point will henceforth be known as Ferry Point Park, because it is undergoing conversion into a recreational area. Similarly, on the Queens waterfront, a large tract adjacent to the bridge is being rapidly transformed, and will hereafter be designated Francis Lewis Park, for historical reasons.

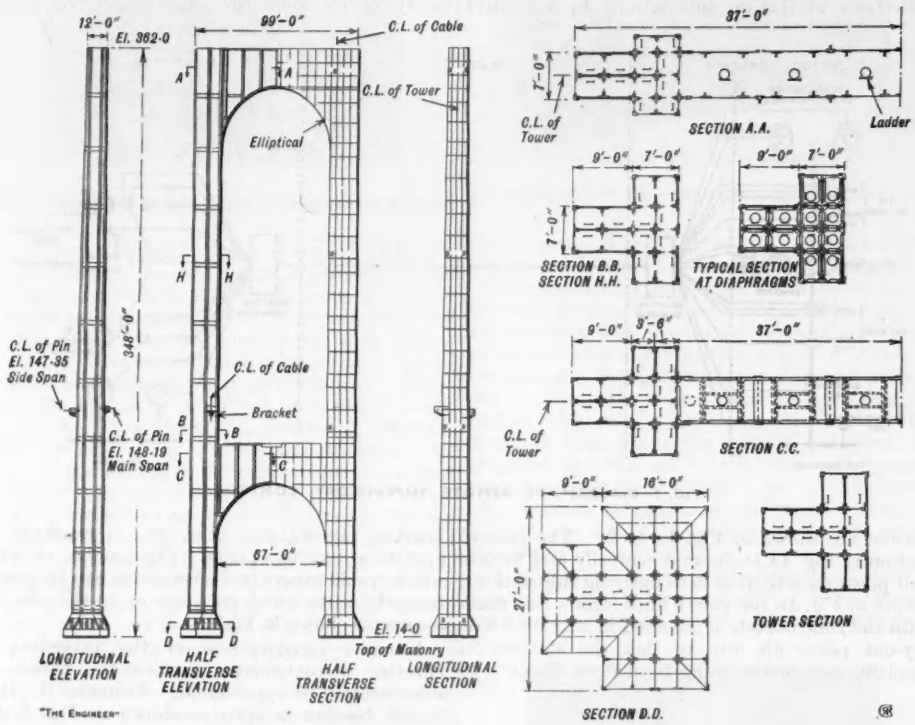
mean high water. Because of the maximum under clearance required by shipping and the low land adjacent to the river on each shore, there are two long approach viaducts and two adjoining relatively short concrete ramps that connect with the two new tributary highways. The two steel viaducts and the suspension bridge have a combined length of 6678·16ft., and the concrete ramps are respectively 187·92ft. and 266·17ft. in length.

The relative merits of a four-lane or a six-lane structure were thoroughly analysed in advance, and the estimates indicated that a six-lane span would cost 3,000,000 dollars more than one wide enough to carry four lanes. The greater outlay was deemed unwarranted, inasmuch as the contemplated four-lane crossing would have a considerable reserve capacity, and would, temporarily, permit a five-lane service—two lanes in one direction and three lanes for traffic moving oppositely under peak load conditions. Furthermore, it was reasonably assumed that before the bridge reached full capacity use in the future, another crossing would be constructed somewhere in the general neighbourhood to afford relief and to amplify facilities for another period of traffic growth.

The two roadways (see illustrations on page 472) are separated by a central twin-kerb steel structure that has a top width of 27in. At its pavement each roadway has a width of 27·5ft., and along each side there is a kerb that slopes away from the roadway, thus increasing the effective width at the tops of the two kerbs to 28ft. 10·5in. The flaring kerbs were adopted so as to permit the movement of three lines of closely spaced automobiles during periods of peak service—the tyres of the two outer lines of cars being virtually in contact with the kerbs at the roadway level. This very practice has been followed on the George Washington bridge, which has roadways that are each 28ft. 9in. in width between their vertical kerbs. The provision of sloping kerbs increased the cost of the bridge by only 250,000 dollars, as against a possible added outlay of 3,000,000 dollars had the structure been designed for two three-lane roadways that would be used at capacity but infrequently.

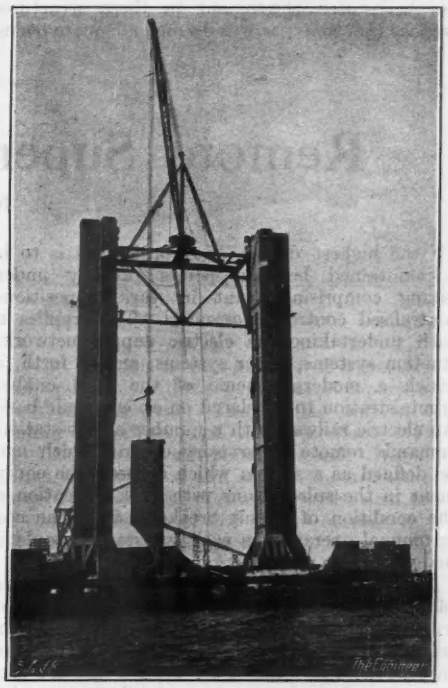
The Bronx-Whitestone bridge and the Triborough bridge, because of their proximity to one another, are competing for traffic, and it has been estimated that the newer crossing may lead to a diversion of as much as 26 per cent. of the traffic that would otherwise use the Triborough bridge to cross the East River between The Bronx and Queens. It is believed that as many as 6,500,000 vehicles will use The Bronx-Whitestone structure during its first year of service, while 9,500,000 vehicles will cross by the Triborough bridge in the same time. By maintaining the same toll rates *vid* either bridge—that is, 25 cents for a passenger car and from 25 to 75 cents each for trucks or buses, the revenue from the two spans will be ample to meet both interest and sinking fund charges. The two bridges, either separately or conjointly, will therefore be self-liquidating. To stimulate travel by way of The Bronx-Whitestone bridge, the Authority has constructed two typically up-to-date approach highways, capable of satisfying on an ample scale all modern traffic demands, and susceptible of expansion to meet future needs. These approaches are strips of property that range in width from 250ft. to 400ft., and have been developed as parkways. The Bronx and the Queens approach highways have a combined length of about 3·5 miles, and, of course, connect with other highways that have been built to handle large volumes of rapidly moving automotive traffic.

The two main towers at the tops of their cable housings, rise to a height of 377ft. above mean high water, and each tower is set upon a reinforced concrete pier that was carried down to a seating on rock. At the site of the pier on The Bronx side of the river, the rock lies at a maximum depth of 98ft. below mean high water, and on the Queens side the deepest contact with rock is at a depth of 151ft. The steel shaft of each leg of each tower is set upon one of the two solid concrete pedestals or pylons of the supporting pier. These pylons are each 34ft. square in cross section and 24ft. in height, and at mean high water their tops are 14ft. above the tideway. The two columns are tied together transversely by a deep reinforced concrete strut, and each of these pedestals rises from an open caisson, 38ft. square, having four interior dredging wells. The wells were sealed at their bottoms with a course of concrete, but were otherwise left open and are flooded. This was done to keep the foundation pressure as low as possible. The average foundation pressure is 18 tons per square foot, but the corner pressure is 26 tons per square foot.



ELEVATIONS AND SECTIONS OF TOWERS

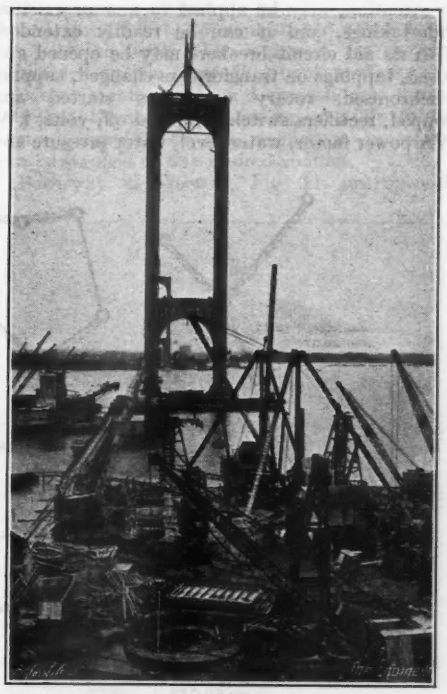
In designing the bridge under Mr. Ammann's guidance, pains were taken to avoid the use of "extraneous architectural embellishments," and thus use well-nigh all the material for the practical purposes of strength and stability. Although the lines of the structure are therefore strikingly severe in their simplicity, yet the bridge is noticeably graceful in its modelling. Each tower is made up of two vertical shafts or legs, that are tied together at the top and below the span by two deep portals. There are no intermediate struts or transverse diagonal bracing. The shafts and portals are of closed box section throughout. Each tower leg is T-shaped in cross section, and the section is subdivided into twelve rectangular cells by means of intermediate webs. The width of the section parallel to the axis of the bridge tapers uniformly from 18ft. at the bottom to 12ft. at the top of each leg, while the transverse width is maintained at 16ft. At intervals of from 8ft. to 13ft. the leg sections are stiffened longitudinally by the interposition of diaphragms. The portals are rectangular box sections, 7ft. wide and 23ft. deep at the centre, and they are stiffened by horizontal and vertical diaphragms. The towers at their tops carry the housings which enclose the cable bearings, and, in turn, are surmounted by the airway beacons. The rigid upper portal of each tower has permitted the placing of the cable bearings off centre in respect to the axes of the two legs—the centres of the two cables being 74ft. apart. The towers have a uniform width of 99ft. from their base structures up to their tops, a feature that contributes an element of austere dignity. The excentric arrangement of the cable bearings made it easier for the designers to achieve a simple and economical development of the floor structure at the towers.



ERECTION OF NORTH TOWER

It is said that the bending stresses in the tower legs, due to this excentricity, are appreciable only near the tops of the towers, where bending stresses that may result from the longitudinal deflections of the towers are of the least magnitude.

Each leg of each tower is secured to a structural steel base, which, in fact, is a spreading development of the leg section, and where the base bears upon the top of the pier pylon it has a longitudinal



ERECTION OF SOUTH TOWER

dimension of 27ft. and a transverse dimension of 25ft.—still retaining the T-shaped characteristic section of the tower leg. The structural steel base in each case is secured to the pier by twenty-four 3in. anchor bolts, which, in turn, engage a steel frame that is embedded in the concrete of the pier.

The two main cables are so placed in relation to the sustaining towers that under normal temperature and full dead load the towers, at their tops, may be deflected 3in. shoreward in a direction

parallel to the longitudinal axis of the bridge. Again, under the most unfavourable combined conditions of live load and temperature, the towers may possibly deflect from this normal position as much as 15in. riverward and 11½in. shoreward, or 12in. and 14½in., respectively, from the vertical position.

Because of the possible maximum combination of axial and bending stresses, conditions dictated the need of fairly uniform shaft or leg sections, and this increases from 1637 square inches at the top to 2070 square inches at the base. Carbon steel has been used throughout in these structures because that material was deemed adequate owing to the adopted dimensions of the shafts. Silicon steel for the minimum sections that were prescribed would have been a waste of material and have added needlessly to the cost.

As explained by Mr. Ammann, "The maximum axial unit stresses in the tower shafts are about one-half of the maximum extreme fibre stresses and less than two-thirds of the permissible stresses for axial compression. The extreme fibre stresses govern throughout. The maximum stress is 21,100 lb. for a combination of dead load, full wind, one-half live load, and one-half temperature."

(To be continued)

Remote Supervisory Control

No. I

IF the highest degree of co-ordination is to be maintained between points of any undertaking comprising plant in various positions, centralised control is essential. This applies to such undertakings as electric supply networks, traction systems, water systems, and so forth, in which a modern scheme of the kind enables administration to be placed on an economic basis. An electric railway with a number of sub-stations demands remote supervisory control which may be defined as a system which controls the equipment in the sub-stations with back indication of the condition of circuit breakers, &c. The cost of manual operation in each sub-station would in many cases be prohibitive.

For the remote and supervisory control the plant is designed or modified to be motor or solenoid operated. The motors could be run, solenoids energised, back indications received, and meter readings obtained by a pilot wire for each operation, but this would result in many wires between the control station and sub-stations, and the system would be entirely uneconomical. By the introduction of the selective principles of automatic telephony, however, the number of pilot wires has been substantially reduced and the limitations at one time experienced removed. In these articles it is proposed to describe some of the principal schemes devised for use on electric supply and traction systems.

The G.E.C. scheme of supervisory control is operated over a minimum number of pilot wires, is rapid in action, is claimed to require virtually no attention, may be applied to new or existing undertakings, and it can be readily extended. With its aid circuit breakers may be opened and closed, tappings on transformers changed, supplies synchronised, rotary converters started and stopped, rectifiers switched on and off, volts, kW, kVA power factor, water level, water pressure and flow, gas pressure, flow, &c., can be read at the control point. Other facilities offered are the starting and stopping of motors for any purpose, telephone communication, and for back indication and alarms with respect to plant operation.

All the facilities normally required can with the G.E.C. system be provided with two pilot wires, linking the sub-stations to the control station, although if more pilots are employed the amount of supervisory control apparatus necessary is reduced. The number of pilots to be used and the method of linking the stations is dependent on the system involved. Attention must be paid to the geographical lay-out and, in the case of existing undertakings, to pilot wires which are already laid. A carrier channel superimposed on the power lines may also be employed, thus entirely dispensing with pilot wires.

Methods of linking sub-stations to a control station are shown in Fig. 1A to D. The control station in Fig. 1A is situated centrally and feeders and pilots radiate from it to outlying sub-stations, whilst in Fig. 1B the power lines form a ring main with the control station included in it. With this lay-out pilots are run to link the stations in tandem, two routes being formed as shown. In Fig. 1C, a power station feeds a principal sub-station, distribution from this point being on a radial system with control from the power station. The principal sub-station becomes a group centre in which pilots from other sub-stations converge. In practice a combination of two or all these arrangements is sometimes advantageous as shown in Fig. 1D.

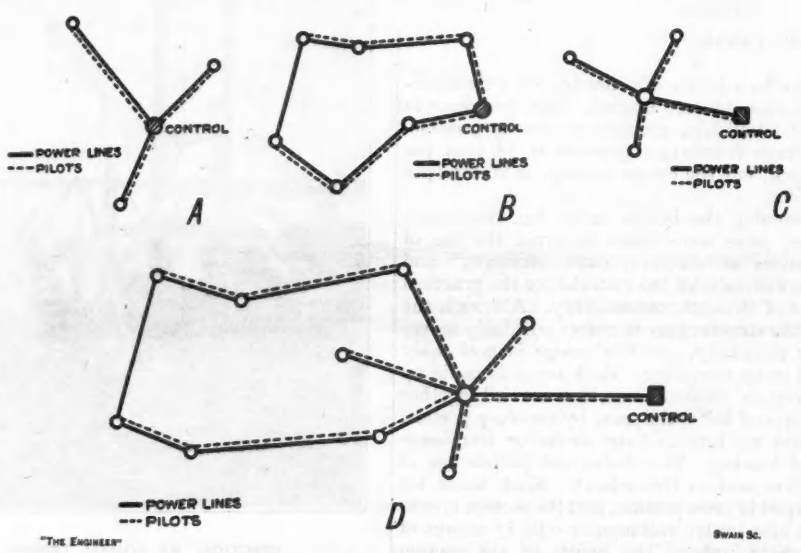


FIG. 1—METHODS OF LINKING SUB-STATIONS

In Fig. 2 is shown in diagrammatic form the application of a remote supervisory control system to an electric supply undertaking. For the sake of simplicity, only one sub-station is indicated. At the control station is a control panel with a mimic diagram representing the entire undertaking. Circuit breakers are represented by rotary keys, and tap changing gear by lever keys positioned in the diagram so as to be associated with their corresponding plant in the sub-station. Adjacent to each circuit breaker key are two indicating lamps, one green and the other red, denoting the "on" and "off" positions respectively. To indicate the condition of the breaker, these lamps glow. In connection with them alternative schemes may be employed. Normally, the lamps may be extinguished and any change in the switchgear may automatically cause the appropriate lamps to glow or the lamps may glow continuously to provide a constant lamp indication of the condition of the switchgear. It is assumed here that continuous lamp indication is employed.

In the sub-station illustrated it must be possible to open and close the H.T. circuit breaker, open and close the L.T. breaker, change the transformer tappings, and read at the control station the current and voltage. In the ordinary way this would necessitate a large number of pilot wires, but with the system under consideration the number of pilot wires may be reduced to two. This is attributable to the fact that the supervisory control apparatus selects the correct circuit breaker, tap-changing gear, &c., in readiness for operation over the pilots. The number of pilots which would otherwise be necessary can be gauged from the wires which converge on to the selective apparatus shown in Fig. 2.

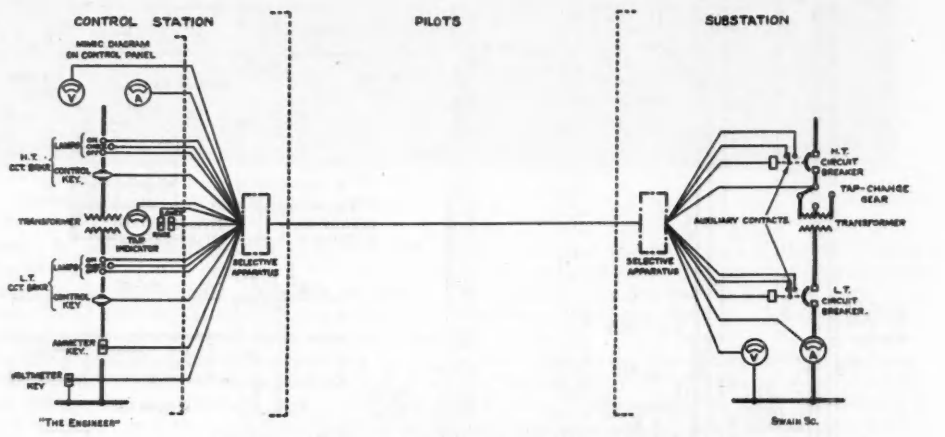


FIG. 2—DIAGRAM OF REMOTE SUPERVISORY CONTROL

From a consideration of the procedure in effecting a particular operation the process of selection will be appreciated. Assuming the H.T. circuit breaker is open as shown in Fig. 2, the handle of the corresponding key will be across the diagram line representing the power line and the green lamp will be glowing. The engineer turns the key to the "on" position, *i.e.* in line with the diagram, and the supervisory apparatus at the control point responds sending a signal over the pilots to the apparatus at the sub-station. This, in turn, responds and selects the circuit breaker for operation. A signal is then sent back and on its receipt a third lamp adjacent to the control key glows to denote that this particular breaker has been selected for operation. A common "operate" key is then depressed, an "operate" current is sent out, and the circuit breaker closes, whilst auxiliary contacts on the breaker send back an indication that the breaker has been closed and causes the green lamp to be extinguished and the red lamp to glow. On the release of the "operate" key, the check back lamp is extinguished. Similar procedure will enable any other circuit breaker to be operated, whilst by means of two "raise" and "lower" keys the transformer tappings can be changed.

Meter readings may also be obtained either continuously or on demand by operating appropriate keys. Summarising the methods by which complete control is obtained, (*a*) mimic diagrams show the conditions of the whole undertaking, (*b*) to perform any operation appropriate keys are turned to the desired position, (*c*) a checkback lamp shows that the plant to be operated has been selected and is ready for operation, (*d*) the operating key is then depressed, and (*e*) the lamp indication changes to show that the operation has been effected.

A noteworthy feature of the G.E.C. system is that a check is provided on the selection of the sub-station apparatus before the operation is actually performed. Unconsidered action is therefore virtually impossible and accuracy of control ensured. Operation is none the less rapid. On an average the period which elapses between the time of turning a control key and the receipt of the check-back signal, prior to depression of the operate key, is approximately four seconds.

In the event of a circuit breaker being manually operated by one of the sub-station visiting staff

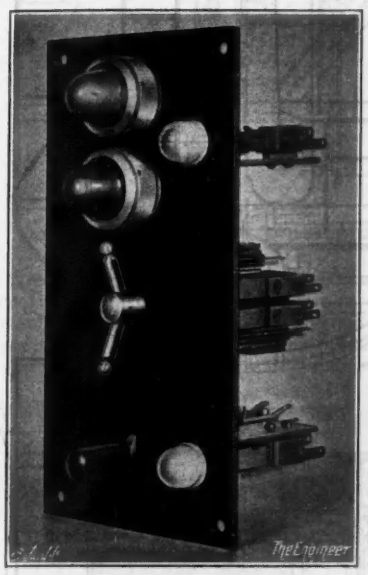


FIG. 3—PANEL FOR REMOTE CIRCUIT BREAKER CONTROL

or being automatically tripped as the result of a fault condition, the supervisory control apparatus selects the affected plant and sends "alarm" signals over the pilots, when the apparatus at the control station responds, changes the lamp indication from green to red or red to green as is appropriate, and gives rise to an audible alarm. Moreover, the indicating lamp last lit is continuously flashed to show which apparatus is affected. When the control key is turned to correspond with the new position of the circuit breaker the alarm is cut off. Hence not only is it possible for an engineer himself to control and supervise outlying plant, but if conditions change without intention he is automatically advised of the change.

The apparatus used in the system is (*a*) that which is incorporated in the mimic diagram on the control panel, (*b*) automatic selective apparatus, and (*c*) interposing equipment employed between the selective apparatus and the actual sub-station plant. Usually the control panel is composed of slate and accommodates apparatus panels, Fig. 3. These panels are linked by painted lines or lines formed of bright nickel silver or coloured strip

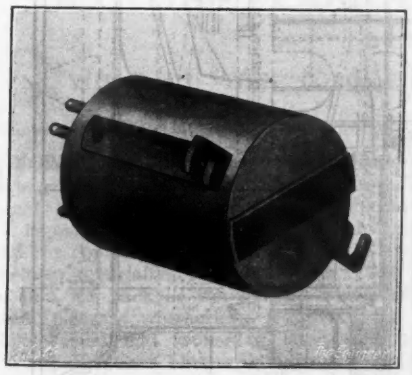


FIG. 4—RELAY SEMAPHORE

to form the mimic diagram. On the panel shown are apparatus associated with a circuit breaker, *i.e.* "on" and "off" lamps, a check back lamp, a control key, ammeter key, and a corresponding check back lamp.

The control key is positive in action, and is definitely fool-proof. No action by the operator can influence the contact pressure or produce false circuit conditions. As an alternative to the duplicate lamps, a rotary semaphore may be employed to indicate the position of the breaker. This semaphore, Fig. 4, comprises an electro-magnetic mechanism and a disc with a coloured or bright metal strip across it. By means of the mechanism the disc can be rotated through 90 degrees so that the strip is either in line or across the feeder line in the mimic diagram. Common to all operations the operate key is a push button of fairly large dimensions and has a very positive action. At the control station the selective apparatus is generally built into the

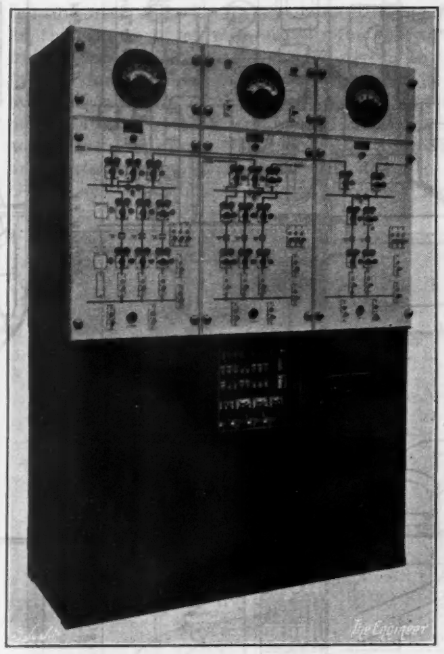


FIG. 5—SELECTIVE APPARATUS AT CONTROL STATION

control panel, Fig. 5, whilst the apparatus at the sub-station is housed in a cast-iron case, Fig. 6.

Identical with those used in automatic telephony the two principal components of the apparatus are the relay and uniselector. Of the same basic types are a two-position relay and a both-way uniselector. In Fig. 7 is shown a general purpose relay. The yoke which carries the operating coil has at one end a knife-edge bearing for the armature and when the coil is energised the armature is attracted to the core and actuates contact springs fixed to the yoke. As the knife-edge bearing is practically frictionless there is virtually no wear and the relay retains its initial characteristics indefinitely.

Relays that are required to possess "slow-to-operate" or "slow-to-release" characteristics have copper slugs on the cores. Another type of

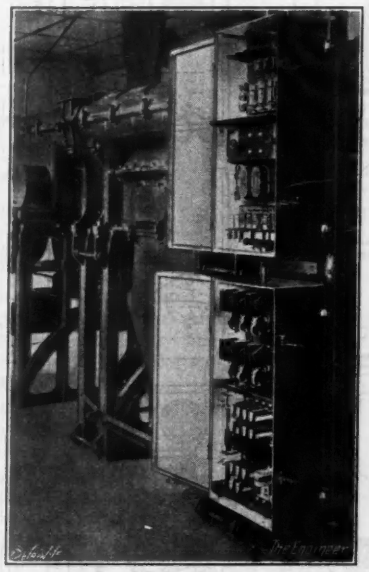


FIG. 6—SELECTIVE APPARATUS AT SUB-STATION

relay is shown in Fig. 8. This differs from the general purpose relay in that after cessation of operating current it remains in the operated position, thus holding a set of contacts actuated. When current flows through a second coil, the first set of contacts returns to normal and a second set is actuated and remains in this condition until current again flows through the first coil. The two component parts are interlocked so that when one is attracted one armature is held in the operated position by spring action until the other armature is attracted.

By means of the uniselector, Fig. 9, the selection of sub-station plant and control station indicators is made. These uniselectors are electro-magnetic switches on which a set of wipers

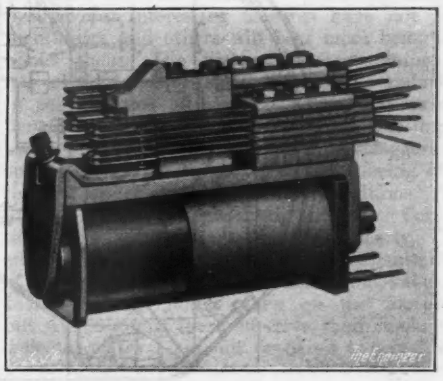


FIG. 7—TYPICAL RELAY

may be brought to rest on any of a number of bank contacts. All the uniselectors employed are practically identical. They differ only in the number of wipers and bank contacts. From Fig. 10 the action will be understood. When the coils A are energised and attract the armature B, the pawl F is carried forward into the next tooth on the ratchet wheel G. If the current in the coils be interrupted the springs H restore the

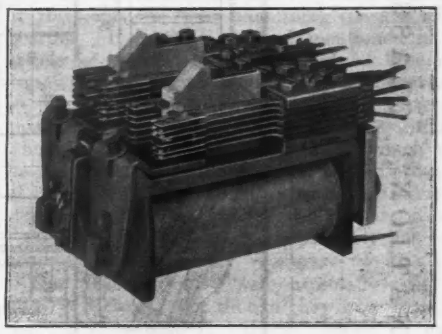


FIG. 8—TWO-POSITION RELAY

armature G, and with its return the pawl pulls round the ratchet through an arc equal to the pitch of the teeth. The wipers K are therefore positioned on the succeeding bank contact. The selector actually steps on a succession of current impulses through the magnets, and by feeding current impulses to the magnets a uniselector can be stepped to any desired contact.

Both-way uniselectors, Fig. 11, are specially

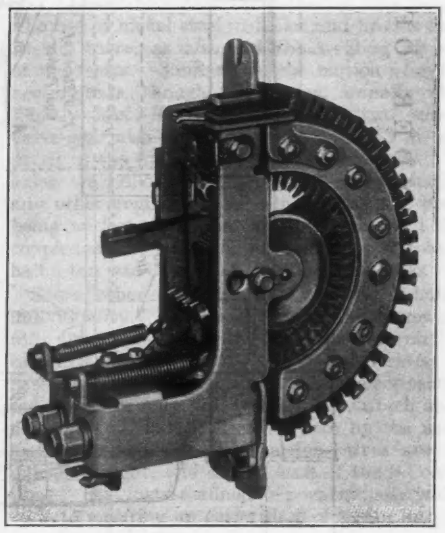
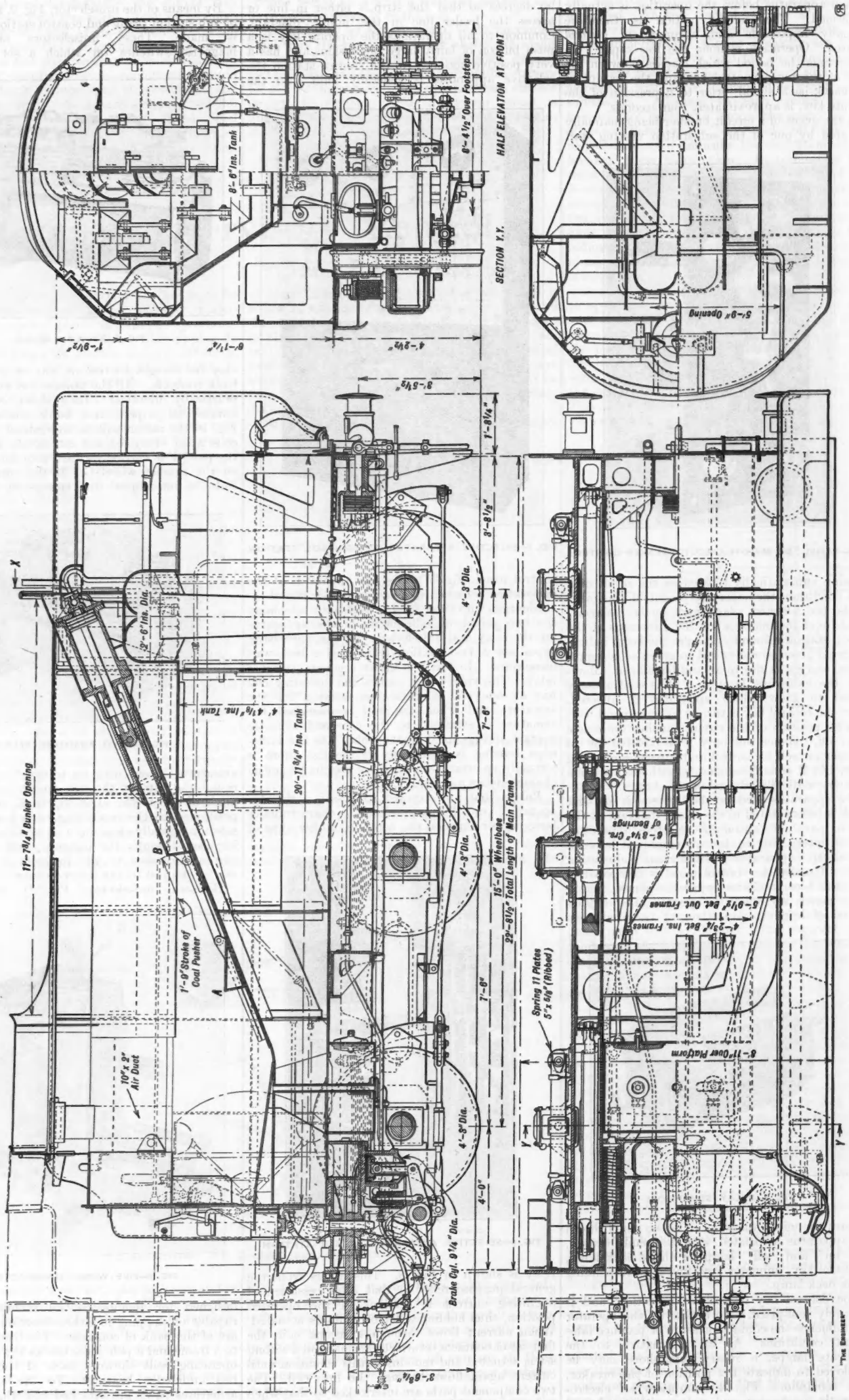


FIG. 9—FIVE-WIPER UNISELECTOR

designed for remote control circuits and are capable of stepping in either direction around the arc of the bank of contacts. The bank is secured to a frame and a pole piece carries the cores of two operating coils shown. Each of the armatures has knife-edge bearings. To the ends of the armatures pawls are attached and when an armature is attracted engage with a ratchet on the

TENDER OF L.M.S. "CORONATION" CLASS LOCOMOTIVE



wiper shaft. By feeding the appropriate coil with current impulses, the wipers can be rotated in either direction. Interposing contactors, Fig. 12, break the current required by the solenoids and motors which operate the sub-station plant, and generally speaking they are mounted in a cast-iron

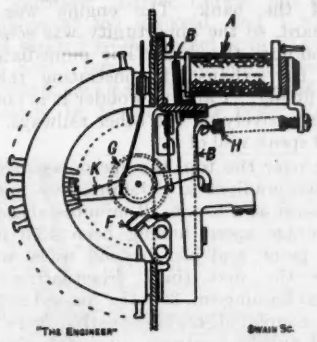


FIG. 10—ARRANGEMENT OF UNISELECTOR

box fixed in a position adjacent to the selective apparatus in the sub-station.

Telephone communication over the pilot wires is obtained by modern bakelite instruments and the control station is called by depressing a push

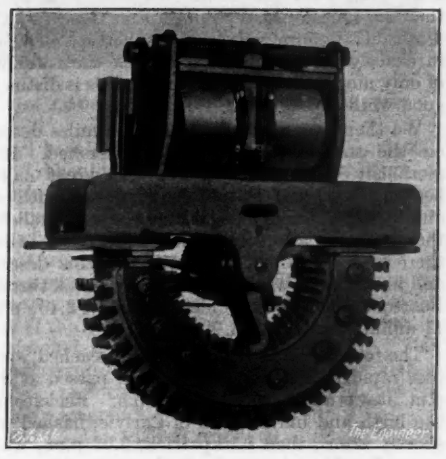


FIG. 11—BOTH-WAY UNISELECTOR

button incorporated in the case. An anti-side tone circuit prevents the transmitter affecting the receiver. In the next article the functions of the various apparatus mentioned will be described.

The importance of remote supervisory control justifies the use of a battery exclusively for the purpose, especially as in the system under consideration the capacity of the cells necessary is low. The voltage required at the control point is only 50 volts, whilst at the sub-stations it may be as low as 24 volts. Cells especially designed for low discharge rates are suitable for the purpose and may be trickle charged from the mains. The main factor contributing to low battery capacity is the use of A.C. transformed from the mains for lighting indicating lamps, the battery being used as the source of current supply for relays and uniselectors. Automatic change-over to the battery for all lamps can be arranged for in the event of a failure of the mains supply, but this necessitates a battery capable of sustaining the additional load imposed during any reasonable anticipated period of failure. But since in the G.E.C. system indication is not given by lamps

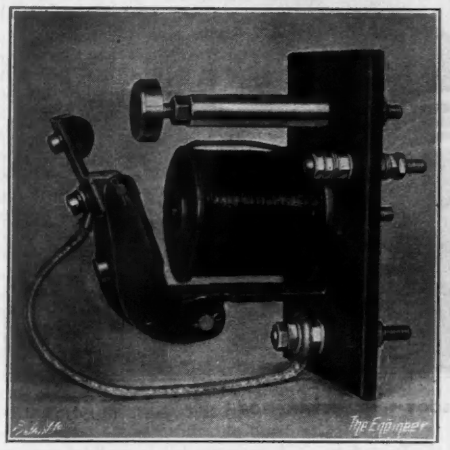


FIG. 12—INTERPOSING CONTACTOR

alone, but is also afforded by the position of key handles in the mimic diagram, such a change-over is not necessary. If conditions at the sub-station remain unchanged this condition suffices for the period of the breakdown, but should any change take place during the failure as a result of local manual action or automatic operation, a flashing signal is given and this is always drawn from the battery. A condition similar to the failure of the supply to the indicating lamps is the failure of a lamp itself in consequence of a broken filament or other cause. But here again the control key will maintain the indication. If a circuit breaker trips automatically and the indicating lamps should fail to light, the flashing of the lamp last lit in respect of this breaker will attract attention and disclose the failure of the other lamp.

(*To be continued*)

Scottish Locomotive Experiences

By E. H. LIVESAY

No. VIII (Part I)—THE "CORONATION SCOT," L.M.S.R.—GLASGOW TO LONDON

(*Continued from page 440, Nov. 3rd*)

I NOW come to the last of my Scottish locomotive experiences, and it is for that reason that I begin the account of it with a considerable measure of regret. My trips had been so interesting, and the courtesy and helpfulness that I had met with so invariable, that naturally I felt sorry to turn my back on the country which had left such pleasant memories. However, all good things must end sooner or later, and as the "Coronation Scot" began to move out of Glasgow Central Station, I felt that there was still some balm in Gilead, because, at any rate, the tour was going to finish on a high note, which, as it subsequently turned out, was sustained to the end. Thanks to the courtesy of the L.M.S.R. I came south with this notable train, than which there is none in Great Britain with a higher reputation, or with a performance more worth recording. Its speed and comfort put it into the front rank, and it has the added distinction of covering a distance of 299 miles between London and Carlisle non-stop. The "Flying Scotsman," of course, exceeds this considerably—during the summer months, that is—but with this exception, the "Coronation Scot's" uninterrupted run is unequalled in the world, so far as my knowledge goes. I refer to steam-powered trains; possibly Diesel-electric equipment in America may make longer continuous journeys, but this I cannot assert positively. The "Coronation Scot" has earned additional repute from the exhibition of a replica at the New York World's Fair, where it cannot fail to enhance the reputation of British railway material; its presence there is much to the credit of the L.M.S.R., which has shown such enterprise in sending it across the Atlantic. Just as was the case with the "Royal Scot's" North American tour, no doubt some valuable lessons will be learned by railwaymen on both sides of the "Pond" from its runs over transatlantic metals. In this connection, I cannot help expressing regret, which I feel sure is shared by others who are interested in locomotive work, that a critical and detailed account of its performances under these strange conditions has hitherto not been given publicity. The operation of a representative British engine and train over American railways is surely a matter of considerable interest, to which justice should be done. Very little of value was written in technical journals about the "Royal Scot's" tour; it was largely unhonoured and unsung. So far, it seems that the "Coronation Scot's" running has been similarly passed over. An opportunity has been missed here for useful comparisons, but perhaps there is still time for the omission to be rectified.

The "Princess Coronation" class of engine, employed on the "Scot," has already been described to some extent in preceding articles, but several interesting features have not been mentioned, and others will bear more being said about them. The matter of streamlining: it has obvious advantages, such as the reduction in some degree of wind-resistance, but as this benefit is not felt below 60–70 m.p.h., the importance of the saving can easily be exaggerated, speeds greatly in excess of this not being often reached under normal running conditions. The following log of an actual trip with the "Coronation Scot" will bring out this point clearly. The effect of streamlining in raising the exhaust clear of the cab is certainly of considerable value, as I have always noted when on the footplate, but whether it is more effective than smoke-box deflector-plates I am not prepared to say; both are beneficial.

Streamlining undoubtedly has one drawback, and I have never spoken to a fitter who did not point it out. For instance, my cicerone at the New York Central Harmon shops—the first guide I chanced upon in my pilgrimage, and one of the most outstanding expositors I have had in all these locomotive experiences—was emphatic in his complaints as to the difficulty of getting access to mechanism hiding behind streamlining. His name was Stone, and he fully deserves any encomiums I can give him, even at this late hour. I have never forgotten him, or his painstaking thoroughness in showing me everything of interest at Harmon. We were examining the fine roller-bearing "Hudsons," which I mentioned in the article of March 17th. He said: "Whenever you want to get at anything, it's almost sure to be behind those darned plates!" Fitters in this country have voiced much the same criticism, which is probably justified, however much may be done to mitigate the nuisance by the provision of inspection-doors. The advertising value of streamlining should not be overlooked; it is a "talking-point," and as such probably has some consequence.

The "Coronations" were especially built for high-speed work, and though they were based on the "Princess Royal" design, which in many respects is similar, quite a number of variations had to be made to fit them for their more strenuous duties. The driving-wheels are 3in. larger, and the cylinder diameter was increased by a quarter inch, in order that the tractive-effort might remain practically the same. This, in turn, called for a larger firebox, which has an area of 50 square feet, 5 square feet more than the "Princess Royals." As the allowable axle-loading, 22·5 tons, had already been reached with the latter, the increased dimensions had to be attained without any increase of weight, and so the knowledge of the metallurgist was utilised to off-set difficulties in this respect. The use of nickel steel in boiler and firebox saved weight there, as also did the welding of some of the seams. Similarly in the motion; the connecting-rods, though 2ft. longer, actually weigh slightly less. The elimination of two sets of valve-gear also reduces weight, and 412 lb. were saved in the four sections of coupling rods. The axles are hollowed to a greater extent than on any other engine I have come across, the boring being no less than 4½in. on the second and third coupled axles, and 3in. on the first; a total of half a ton was cut out in the six engine axles.

Some other details are of interest, showing individuality. The small ends of the connecting-rods have an unusually large oil reservoir, not cast in the rod, but fitted to the top sides. In passing, it may be mentioned that the connecting-rod webs are only ⅜in. in thickness, which shows how material has been saved here by the use of nickel-chrome steel. The piston-valves are also unusually light, and one at least of the "Coronations" has "streamlined" port-bridges, with a view to ensuring an easier flow of steam into and out of the cylinders.

The divided drive brings up the matter of balancing, but here I am on debatable ground, over which I will leave others better qualified to fight. The inside cylinders drive the first coupled axle, and the outside pair the middle one.

In this connection I will quote a very interesting description of the "Coronations" which I chanced upon recently. "In the 'Coronation' engine, 50 per cent. of the reciprocating weights are balanced, equally divided over the three coupled

axles (see diagram below). In a four-cylinder engine, it is possible to eliminate axle hammer-blow altogether, so long as the same amount of reciprocating weight is balanced in both inside and outside motions.* There remains, however, a small hammer-blow on each wheel, and it is, therefore, desirable to reduce the value of the weights as far as possible. In the 'Princess Royal' class locomotives, the hammer-blow on each coupled wheel is 1·31 tons. For the whole engine, it is 0·24 tons, and for the whole engine per rail 3·47 tons. Exactly the same figures obtain for the new 'Princess Coronation' class engine." This is, of course, very thought-provoking; it is probably my mental limitations that make it difficult for me to understand how hammer-blow in one axle can be eliminated by anything done to another. I still need enlightenment on this point. However, the proof of the pudding is in the eating thereof, and the engine as a whole is certainly very well balanced indeed, disturbances due to the reciprocating and revolving parts having always been conspicuous by their absence during the runs I have made on both "Princess Royals" and "Coronations." This has subsequently been proved beyond a peradventure by two trips on "No. 6202," the turbine engine, which, of course, has no disturbing mechanism whatever, except the coupling-rods. I could detect so little difference in action between this outstanding engine and a "Coronation" in good shape that I am really unable to decide definitely whether there is any. To the best of my recollection, one is about as good as the other, which speaks well for the excellent balance of the reciprocating class.

One other feature of the "Coronations" merits a word or two—the coal-pusher in the tender which I believe is unique in this country. It came from America originally, where fireboxes had become so big that the firemen had all their work cut out to keep them supplied, and had no longer time to get into the bunker and handle the fuel twice. I touched on this inhumane task in the "Mid-day Scot" article (THE ENGINEER, September 1st), and described how the absence of a coal-pusher affected both Fireman Stones and myself, engendering a fellow-feeling that endures to this day. The drawing on page 466 shows the arrangement of the pusher, and is almost self-explanatory. The two nearly vertical surfaces A and B push the coal forward, the steam being admitted into the cylinder by the fireman as required for each thrust. The device is, naturally, not used until the coal in the front part of the bunker, normally within easy reach of the shovel, has been used up. It is a most useful fitting, and, in the absence of mechanical stoking, is certainly needed on engines having 50 square feet grates.

GLASGOW TO CARLISLE

The route from Glasgow to Carlisle can be dealt with briefly, as it has been described before in preceding articles, though chiefly from the point of view of an engine travelling in the opposite direction. The average inclination for the first 52 miles out of the Central Station is upward to Beattock summit, 1014ft. above sea-level, after which there is mostly a downward gradient over the succeeding 50 miles into Carlisle. Continuing southward, another long pull begins at once, of 31 miles, ending at Shap Summit, 915ft.; thence it is chiefly a descent for a further 31 miles to near Carnforth. Broadly speaking, the 165 miles from Glasgow to Carnforth include most of the heaviest gradients on the "Coronation Scot's" route, the remaining 236 miles to Euston being far easier, with nothing to cause any real concern to a powerful engine handling a moderate load. On the northern heavier portion, too, there are speed restrictions due to gradients, pit-subsidences, etc., whereas there are fewer of these annoyances on the southern section. I cannot look on the L.M.S.R. Glasgow–London line as being really hard, save for the two very heavy stretches to the Beattock and Shap "peaks"—I emphasise these two severe exceptions—which are among the worst to be found on any main line in Britain. As I have been over its full length four times on the footplate, and have made a couple of runs over the southern half in addition, observing its features pretty closely from an engine-operational viewpoint, I am beginning to understand its potentialities fairly well. Only on Beattock and Shap have I ever noticed "Coronation" class engines seriously stressed, and even then the trains were not really heavy. I should enjoy being on the footplate of a "Coronation" when handling a 600 ton load, going "all out" up Beattock—it would be an experience worth recording!

THE UP "CORONATION SCOT" AT ELVANFOOT

On the occasion now to be described, the engine was No. 6224, "Princess Alexandra," in charge of Driver Marshall and Fireman Tough, the load being the usual 300 tons for which the nine streamlined cars are responsible. The "Coronation Scot" pulled out of Central Station punctually at 1.30 p.m., and I took a last regretful look at the Clyde as the engine rolled out over the bridge on 20 per cent. cut-off, and with regulator fully open. Speeds to Carlisle must be regarded as only approximate, the indicator being out of action. To Rutherglen Junction, the contour is fluctuating, but then it begins to rise sharply, and at Cambuslang, 4½ miles, passed in 7 minutes, it shows a gradient of 1 in 163; shortly afterwards, at Newton, a couple of miles on, the 60 m.p.h. rate which had been reached was reduced sharply to 15 m.p.h. for a pit subsidence, and the speed had to be raised all over again. At Uddingston, 8 miles, passed at 1.42 p.m., a long and heavy climb begins, continuing for 16 miles to just beyond Craigenhill Siding; it was topped at 2.3 p.m., the average speed so far having been 43·6 m.p.h. As the climb had been entered upon at about 30 m.p.h., due to the speed restriction at Newton, this is quite good, and we were doing 60 m.p.h. over the summit. On the way up, passing Motherwell, 13 miles, at 1.48 p.m., we were a minute ahead of time, in spite of the reduction to 15 m.p.h. just before the foot of the bank. The engine was working fairly hard, so the opportunity was seized to use the sand gun, the dusky hue immediately taken on by the exhaust demonstrating the efficacy of this fitting. I always wonder it is not adopted more extensively on the other railways. Enginemen all speak well of it.

Once over the top, the speed began to rise on the down gradient to Carstairs, 28·8 miles, which was passed at 2.8 p.m., 2 minutes ahead of time, the average speed having been 45·5 m.p.h. up to this point, and just beyond water was picked up for the first time. Fluctuating gradients follow to Lamington, 39 miles, passed at 2.18 p.m., still a couple of minutes early; here the final upward pull to Beattock summit begins, through Abington—2.23 p.m., 44 miles—and Elvanfoot. There is a brief "rest-and-be-thankful" of about a mile at Elvanfoot, but just afterwards, the final two miles of 1 in 99 to the top begins. Valve-travel became a little longer, and the exhaust took on a more determined note. It is generally almost inaudible. The summit was passed at 2.30 p.m., with the 2 minutes still in hand, so the 52·6 miles of heavy going from Glasgow, with 4/5ths of it on upward gradients, had been covered in exactly an hour. Even though the train was of only moderate weight, 300 tons, this is distinctly good work.

We then began the very steep 14 miles descent on the southern side of the watershed. It is gloriously wild country here, with great naked, heather-clad hills, the main road, dotted with cars and trucks spinning along it, more or less paralleling the track for a considerable distance. I believe there is a 60 m.p.h. restriction on this descent, and in any case, we suffered a signal check through Beattock Station, 62·6 miles, passed at 2.40½ p.m., 1½ minutes to the good.

The foot of the restricted descent reached, speed rose rapidly, and at Nethercleugh, passed at 2.50 p.m., it was approximately 80 m.p.h. Ecclefechan, the birth and burial place of Carlyle, flashed past shortly after; then Kirkpatrick, 3.03 p.m., where we suffered a signal check down to 30 m.p.h., resulting in our gain being lost, as Gretna, 93·7 miles, was passed dead on time at 3.07 p.m. Floriston troughs replenished the water-supply shortly afterwards, and we came to a stand in Carlisle's curved station at 3.14½ p.m., ½ min. ahead of time. The average speed over the 102 miles from Glasgow, covered in 104½ mins., was therefore 58·6 m.p.h., a maximum of about 80 m.p.h. having been reached once. Streamlining had had little chance to earn its cost on this section. My previous "Coronation Scot" run (ENGINEER, April 7th) had shown 104 mins. over this same distance; close correspondence.

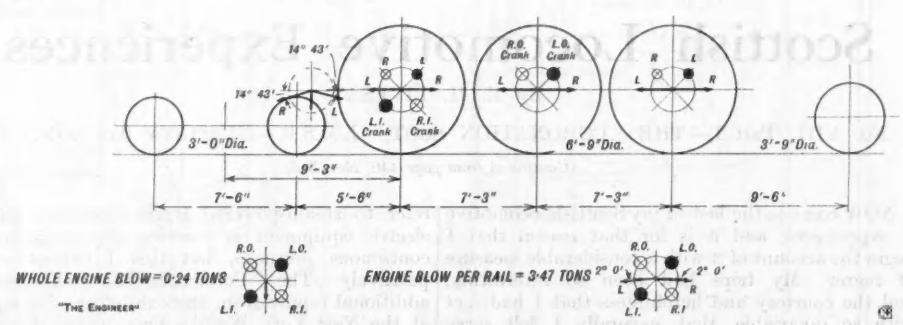
Marshall, Tough, and myself all left the engine here. I was spending the night at Carlisle, in order to renew acquaintance with two well-known retired drivers: Curran, who had been in charge of the first "Coronation" on which I had ridden (THE ENGINEER, April 7th), and Gilbertson, who had handled the "Royal Scot" in America.

	Bogie	Slidebars	1st Driving	2nd Driving	Trailing	Truck
Axle Hammer Blow		0·24 Tons	Nil	Nil	Nil	
Wheel Hammer Blow (Max.)		0·48 Tons	1·31 Tons	1·31 Tons	1·31 Tons	
Static Loads (Streamlined)	22·5 Tons		22·3 Tons	22·3 Tons	22·5 Tons	18·5 Tons
Static Loads (Non-Streamlined)	21·5 Tons		22·25 Tons	22·25 Tons	22·45 Tons	16·8 Tons

Calculated at 5 R.P.S.

4-16½" Dia. Cylinders

Cranks at 90°



AXLE DIAGRAM OF "CORONATION" LOCOMOTIVE

* Surely, provided the motions drive on the same axle?—E.H.L.

The former greeted me as I got down; all his years on the road have not cured him of his interest in locomotives, and I know he is only really happy when at the regulator.

The break at Carlisle gave one more instance of kindness met with from the enginemen under whose care I have been placed during these numerous journeys. Driver Curran put himself and his house at my disposal, and I had the pleasure of making fresh contact with Gilbertson, of "Royal Scot" fame. The evening spent with him in recalling incidents of that memorable tour will not easily be forgotten. I never thought,

THE LOOK AHEAD—DUCHESS OF HAMILTON

when I saw him leave Vancouver on "No. 6100," that I should spend several pleasant hours of "much argument about it and about" in Carlisle with him six years later. But it only goes to show that when one casts one's bread upon the waters it often turns up trumps—my metaphors insist on getting mixed. The talk with Gilbertson made me more than ever regret that no complete and detailed story of the "Royal Scot's" tour was ever written, as it would have been so very interesting. May I again express the hope that the "Coronation Scot's" performances in America will not be similarly ignored?

(To be continued)

Fuel Technology and the War*

I THINK we are doing the right thing in continuing our meetings at the present time, as the war and the difficulties and complexities it involves make us realise, with ever increasing force, the immense importance of the Fuel and Allied industries.

The practice is often followed in Presidential addresses of making a survey of the past, present, and future of the industry in which the particular body addressed is interested, or of dealing with some new specialised aspect which may be of general interest. Although a state of war might make this an appropriate task, it would be impossible to perform it adequately in the time at my disposal. Nevertheless, as we are at war, and already have been brought up rather sharply against several hard facts, it may be a fitting opportunity to review some of the basic factors in the situation which deserve, and in fact might be said to demand, our earnest consideration. I propose, therefore, to survey quite briefly some of the problems which already are indicated. Firstly, there are those cases in respect to which we are now beginning to realise how much better off we should be if we had applied ourselves in peace time to the manufacture in this country of some of the materials which play such an important part in our fuel and heavy industries.

Before dealing with the products which we do not manufacture here, I would like to mention briefly some new aspects of an old question which has been so often discussed in the past. The war has focussed attention once more upon the vital importance of oil. We should, I submit, be extremely grateful to the leaders of the oil industry for their enterprise, foresight, and devotion to the interests of this country, which has placed us in the satisfactory position in which we find ourselves to-day. The task of preparing for war has been immense and extremely difficult, and it has only been possible to bring it to its present stage by a spirit of unselfish co-operation. Naturally, there are all sorts of details arising out of the working of this new machine which cause dissatisfaction and grumbling, but that must not cause us to lose sight of the fact that a great work has been and is being done, without which we should have been in a very different position.

One effect of the war, however, has been to raise the question of which is the right policy in peace time—to import crude and refine here, or import the finished products. The problem is twofold, the oil production aspect is one and the other the necessity of reducing the unfavourable balance of trade in peace time and giving employment, and of safeguarding sterling as much as possible in war. In 1938 our oil imports were divided roughly as to 80 per cent. refined products and 20 per cent. crude, the values being 2·2d. and 3·7d. per gallon respectively. Of these imports, which together totalled 3208 million gallons and cost over £46,000,000, only 8 per cent. in value came from Empire countries. There would, therefore, be a considerable saving in foreign currency if a greater proportion of the country's oil requirements were imported in the form of crude. According to some very informative statistics recently prepared by Dr. Kind, there would be a saving in foreign currency of nearly £2 per ton on the basis of 1938 prices, and a much greater saving this year, both before and after the outbreak of war. Most of the material required in the construction of refineries can be obtained in this country, and modern plants can operate on almost any grade of crude oil and produce up to 97 gallons of finished refined products from 100 gallons of crude oil.

It is interesting to note that in France in 1929 the crude oil imports were only 5·6 per cent. of the total as against 85·8 per cent. in 1938, and the importation of refined products fell during the same period from 94 per cent. to 14 per cent. In Italy also in the same nine years the crude imported increased from 4·6 per cent. to 57·6 per cent. of the whole. These are most striking figures indicating clearly what enormous strides have been made in the refining industries in those countries in the last ten years.

Another advantage in having home refineries is due to the fact that the products provide the raw material in the shape of gases and intermediate products for high octane petrol, toluene, and many other valuable chemical products, and this utilisation of refinery by-products has become in the U.S.A. a most important and profitable business.

Let us next look at the question of the manufacture of calcium carbide, of which there is no production in this country. The imports in 1938 totalled approximately 65,000 tons, of which 35,000 tons came from Norway. Had this tonnage been made here it would have necessitated the consumption of 68,500 tons of calcium oxide, 52,000 tons of low or high temperature coke or anthracite, and 163,000 tons of steam coal, in addition to sundry other materials. The establishment of the carbide industry here, important though it is in itself, would stimulate other industries for which it would provide the raw materials. For example, the production of cyanamide which is made by combining carbide with nitrogen at high temperatures. Cyanamide is not only a high-grade fertiliser, but is also in turn a raw material for ammonia, nitric acid, and ammonium nitrate, the latter being required both as a fertiliser and for the explosives industry. In addition, there is the very important group of chemical industries based upon acetylene. One of the most important derivatives is acetaldehyde, which can be converted quite easily into alcohol, acetic acid, acetone, and rubber. For this latter product acetylene is in America converted into vinyle compounds, or in Germany into butadiene from which their buna rubber is manufactured. The four chief factories in Germany should, if allowed by the course of events, produce in 1940 no less than 75,000 tons of buna rubber.

These compounds are also a raw material for several varities of plastics, and for special varnishes of industrial importance. These are only some of the processes and products resulting from the carbide industry, and its size and significance may perhaps be envisaged from the fact that the American Union Carbide and Carbon Corporation, which bases its chemical production mainly on carbide, made in 1936 a net profit of 34,000,000 dollars, and operates in the United States and Canada more than 160 factories.

Another electro-thermal process similar to the carbide process is the manufacture of ferro-silicon, which is an essential raw material for the steel industry, and in 1937 we imported 23,804 tons, mostly from Sweden. More than half this quantity consisted of only 50 per cent. silicon, but had we been making it here and utilising our own low temperature cokes, we could easily have produced a much higher grade, even up to 90 per cent., and in Germany they are already working a ferro-silicon plant in conjunction with a low temperature plant for the manufacture of high-grade silicons. The manufacture of carbide and ferro-silicon can be carried out in the same plant for an addition of only 30 per cent. on the capital cost, most of the plant being equally suitable for both products. This would enable the cost of production to be materially reduced in each case, and if the plant were operated in conjunction with a suitable low temperature carbonisation plant, the overall economy would be still further increased.

Another and more important branch of the fuel industry, which we might have attacked on a large scale, is that known by the generic term synthesis. Efforts were made in this country to enlist Government support for a full-scale trial of the Fischer-Tropsch process, but without success. As you are aware, by this process hydro-carbons are produced by the synthesis of hydrogen and carbon monoxide, and the whole of the original coal is converted, after being coked, into liquid fuels and valuable gases. Germany produces to-day at the rate of 500,000 tons per annum of petrol, Diesel oil, and paraffins by this process, and consumes the equivalent of about 2½ million tons of coke. The latest plant of Krupps is operated on low temperature coke which has been found best for the conversion, owing to its reactivity in the water gas process. The Germans have two main objects in view in the development of this work, firstly the production of a very high-grade Diesel oil with a cetene number of 120, or of a low octane petrol which can be improved by other means, and secondly the establishment of a new industry utilising the aliphatic compounds. For example, the fractions rich in olefines are already used for the manufacture of lubricating oil, whilst the paraffins are oxydised into fatty acids which are used in the manufacture of soaps or converted into glycerine. Remembering that nitric acid is being made by the combustion of ammonia produced from coke oven or water gas, it can be seen that nitro-glycerine can now be produced from coal alone, as is also the case with ammonium nitrate and trinitro-toluole.

It is also important to remember that synthesis is not restricted merely to making oil. At higher pressures and with other catalysts, carbon-monoxide and hydrogen combine to form methyl-alcohol, which is the chief raw material for formaldehyde. This latter, as you know, is the indispensable reagent in the manufacture of plastics. It is also important to remember that other constituents of a large group of plastics are derived from coal in the form of phenols and cresols. The field for the future utilisation of coal along these lines is immense, and many branches are still open for exploitation in this country.

Up to the present I have confined my remarks to processes and products that are already commercially established on a large scale in other countries, but, in my opinion, the work that is now being carried out on these lines will inevitably lead to new developments of the most remarkable character, and offering new and immense possibilities to the coal industry. For example, during the past few years the production of high octane petrol by polymerisation has become vitally important. It is not too much to say that, other things being equal in rival air forces, the power of attack and defence will depend upon the unstinted supply of high octane petrol. It is certain that within limits not yet reached the performance in respect to speed, rate of climb, military load, and striking range is increased in a remarkable degree as petrol of higher octane number is made available.

These facts are, of course, common knowledge, but what is not so generally known is that these high octane petrols can be produced from coal *via* synthetic processes. Even to-day the Fischer process, for example, can be carried out in such a manner as to produce large quantities of mono-olefines. It will be merely a question of time and research to produce by gas synthesis gases rich enough in olefines to be polymerised into petrol. It is known that polymer petrol possesses a very high octane number, anywhere between 80 and 90, but it can under certain conditions reach 100 as in the manufacture of iso-octane from iso-butylene or iso-butane.

The British Navy ensures the defence of this country from attack by sea for reasons that are well known to you all, but the future mastery of the air will fall to that nation that will, and can, manufacture this fuel and design engines and aircraft to use it to the fullest extent of its possibilities. And in this country, which has no oil at all, it is at all events comforting to think that it could be made from coal.

Another revolution will be accomplished if the conversion of methane itself and its homologues into olefines can be carried out commercially. This is a problem of great importance, both for the oil and the coal industries. For the oil industry because of the immense quantities of methane contained in natural gas, for the coal industry because of the high percentage of methane in the gases from carbonisation. To give you an idea of the quantities available, I may mention that in this country five low temperature plants alone yield when in full production at least 25 million cubic feet of methane per week. In addition, unlimited quantities of methane could be produced synthetically by the hydrogenation of coal with hydrogen or even steam at high pressures. The conversion of methane and the polymerisation of the conversion products into high octane petrols is the point towards which I hope we may see the coal and oil industries converge.

After a rather dismal survey of the things we do not do, it is refreshing to pay a tribute to the fine work done by the I.C.I. at Billingham on the hydrogenation of coal and coal oils. Single-handed, and despite many disadvantages, they have raised the process to a high state of efficiency which compares more than favourably with anything done in Germany. Unfortunately, however, the capacity at Billingham is, I believe, only about 150,000 tons of petrol per year, whilst the German plants now have a total capacity of 1,600,000 tons per year. It is interesting to note that about half the German total is derived from the hydrogenation of low temperature oil, whilst

N

* Presidential Address by Col. W. A. Bristow, M.I.E.E., F.R.Ae.S., Vice-President of the Institute of Fuel, on being installed as President of the Fuel Luncheon Club, October 26th.

the low temperature coke is used in water gas producers for making the hydrogen.

It is, I think, clear that we must embark upon a full-scale wide fronted attack upon these many problems if we are to maintain our place in the world. In planning this attack, we should also not forget that in other parts of the Empire there are already valuable facilities for undertaking some of the work I have outlined, and I think we should not overlook these possibilities. These things are not matters of test tubes, but of human destinies, and with our heavy and continuous adverse balance of trade, we cannot afford to waste even a year before tackling these great tasks.

What is it that stands in the way ? Certainly not lack of skill, knowledge, or courage. I think the system is to blame. We have no co-ordinated constructiveness in the fuel and chemical industries. We all shovel hard in our own ditches and only occasionally look over the top to see what our nearest competitor is doing. We have no Ministry of Heat, Light, and Power which should be the greatest and best equipped Ministry in the country, and there is almost complete absence of national planning by the many sections of the industry. Another powerful deterrent to progress is the financial system by which industry is operated. Nearly all the large concerns are limited companies run by Boards of Directors, who in turn are slaves of the financial whip-crackers who ceaselessly remind them, quite properly, of next year's balance sheet and the rate of dividend expected. I cannot envisage the Chairman of any of our large companies competent to embark upon some of this work standing up before his shareholders and explaining that there was no dividend for them as they had spent all their profits on experimenting with the methane molecule in the national interest. No ! I feel sure it cannot be left to chance and the occasional advances of lone adventurers, that way would leave us hopelessly in the rear. The State provides the Army, Navy, and Air Force for our national preservation, to which we all have to contribute according to our imaginary ability. It is now also necessary in my opinion for the State to establish a Commercial Research Force, not only to undertake pure research and experimental work, but also to operate plants of ample capacity in order that these processes can be brought to fruition. If these things are, as many of us believe, of vital importance to the future of this country and the Empire, then it is only logical that each should pay according to his ability as in the case of the other National Services.

There are additional and most weighty reasons that should compel us to embark upon some of this work without delay. We have been late in preparing for this war because so many of us believed that nobody could be as insane as to make fresh wars in Europe for the sake of " one man's senseless ambition," as Mr. Chamberlain has tersely put it. We were wrong, and now we have to work night and day to make up for lost time. Let us take warning from that and begin to work *now* for winning the peace. When our hundreds of thousands of young men return victorious from the war, what shall we have ready for them ? Are we now to plan for peace as we now plan for war, or are we going to be content to leave it to chance and luck as to whether they are going to be given a new start in life, or decay morally and physically on the dole as long as we are able to pay it, which incidentally might not be very long ?

What happened after the last war ? The collieries, which had played such an important part in the Allied victory, were left to their fate, and in 1926 the country was brought to the verge of revolution. As a result of subsidies, of voluntary increases in contract prices, and the Mines Act, chaos and bankruptcy were narrowly averted. But what is going to happen after this war ? I cannot see that it is going to leave the coal industry any better off than it was after the last, and as we all know it suffered almost more than any other industry. And none of us sitting here can do anything to help it. We shall all be animated with the keenest possible desire to do all we can in our own limited spheres, but we shall all have to wait for the miracle of returning prosperity to bring our hopes and desires to fruition. And what chance will there be of prosperity unless we plan for it and lay the foundations now ? Immense taxation, collossal fall in national revenue, impoverished foreign markets, a crushing adverse balance of trade, and no spare capital left.

Much of the work I have described has been carried out in Germany to prepare for war; is it too much to ask that in this country we should show similar commercial courage and resolution in order to prepare for peace ? I suggest that it is essential that at the end of this war the national effort directed by the Government shall continue unabated in order that we may be as victorious in peace as in war, and that we plan finance and commence that great effort now. We cannot leave the fate of our returning armies to luck, and we must safeguard the future of the coal, oil, and allied industries of this country.

And unless we do that we shall lose the war, no matter how thoroughly we may have obliterated Hitlerism in the field.

South African Engineering Notes

(By our South African Correspondent)

Boom in Union Industries Expected

THE belief that there will soon be a boom in South African industries is being very generally expressed. It was the Great War of 1914–1918 which set South Africa on the road to becoming an industrial country, with the result that to-day there are over 7000 factories in the Union, and in Southern Transvaal alone over 150,000 men and women are employed in factories, giving a total output of £60,000,000 and using £19,000,000 of Union materials and being paid over £20,000,000 in wages—all this being apart from the activities of the gold mines in that area. It is expected that the impetus given to Union industrial expansion will be at least in the nature of a minor boom. The war will undoubtedly curtail South Africa's imports, and local industrialists will be encouraged to establish further industries to supply those commodities that will be curtailed. Certainly industrialists are confidently looking forward to a boom in South African industries. The war will certainly give rise to the manufacture in the Union of a commodity which is imported in large quantities—chloride of lime, which is largely used by Municipalities for water filtration at swimming baths and in purification at sewage disposal works. Two municipalities are already considering starting it as a by-product by the Waterworks Department. A number of firms are working at full pressure to meet big increases in orders which have recently been placed with them. The new situation has given a big fillip to many local firms, some of whom are unable to keep pace with orders. Increases are reported ; and some firms are considering reconditioning old plant to increase their outputs. Other employers, notably in the building industry, are looking forward to a lean period. Some of the smaller firms have already had to put men off, for with the increase in the price of materials a falling off in building orders has begun. Timber has risen in price by 30 per cent. in a week, and most firms have orders frozen in the Baltic. Labour which has been dismissed, principally in the building industry and from German firms which have closed down is, however, mostly offset by the men taken on in other businesses. Clothing manufacturers are working at top speed, and in most factories extra men have been taken on already. In the past 10 to 20 per cent. of the clothes bought in South Africa were made overseas, and the inevitable increase in the prices of these articles has stimulated production locally. Brick manufacturers are anticipating a lean period. They will be hit by the falling off in building. Manufacturers of tiles, on the other hand, are looking forward to prosperity during the war. In this market South Africa supplies two-thirds of her own requirements, but the balance consisting of a cheaper imported product will be very difficult to obtain. The popular shingles, too, are all imported, and a scheme which has been considered for some time to erect a hardwood shingle factory in South Africa will receive a considerable fillip as a result. Furniture factories are only having normal orders placed, and prices have not yet been advanced. The anticipated rush to place orders in advance has not taken place, and if prices do advance later the increase should not be big. As a matter of fact, the local factories can more than supply demand, and overproduction frequently causes short time and even closing down. But, of course, as has already happened in other lines, the buying public may suddenly become obsessed with the idea that a big demand for furniture is imminent, and then anything may happen.

Curtailing Rail and Air Services

An immediate consequence of the entry of the Union of South Africa into the war with Germany has been the curtailment of the Union's railway passenger services and also the air services between the large cities of the Union, while one or two new air routes, only just inaugurated, are being abandoned for a period which may be as long as the war lasts. The aircraft which operate the services have been taken to form scouting or bomber squadrons. There are now only two services per week between Cape Town and Johannesburg, and between Cape Town and Durban, instead of six as in normal times. There is only one service per week between Port Elizabeth and East London, Johannesburg and Kimberley, and one service between the Union and Rhodesia. The two fast trains up and down weekly are stopped. The Union is fortunately well supplied with locomotives and other rolling stock, having only recently received delivery of 42 locomotives, a batch which completes delivery of an order for 430. The various electrification schemes, new railway construction, and dock extensions at Cape Town, Port Elizabeth, and East London, are well advanced. Durban's £3,000,000 works for the provision of additional deep water berths, etc., is the only one of the schemes which is less than half completed.

Steel Shortage Feared

The war is having a serious effect on steel trade in South Africa, and a shortage in the near future is considered likely. Cables received in Johannesburg from the United States and Australia state that the mills in those countries are at present working to capacity, and the receipt of new orders has been temporarily suspended. Australia has embarked on a large defence scheme, and America, apart from recent large contracts, is apparently anticipating a steel boom as a result of the Neutrality Act being amended. Iscor can supply only about one-third of the steel requirements of South Africa. It has maintained its usual prices up to the present, but it is unlikely that it will be able to increase production to meet the needs of the whole country. It is stated that there are sufficient quantities of steel plate, structural steel, galvanised corrugated sheets, flat sheets, and wire in the country for a while, and that the demand may fall off temporarily with the slowing down of large-scale development.

Railway Earnings

Railway earnings as yet show no signs of falling. In fact they have improved. For the week ending September 9th the railway earnings amounted to £680,773, which is £58,000 in excess of the earnings for the corresponding week of last year, and for the week ended September 16th the earnings were £696,236, being £68,000 above the corresponding week of last year, while the week ended September 23rd went £2000 better, with £70,000, a figure which exceeds any previous week as far as one can ascertain.

Maintaining British Export Trade

The British Government is determined to maintain its export trade as far as possible. This information is contained in a communication which the Cape Town City Council has received from the contractors in England who are building 55 trolley buses and six motor buses for the City. The contractors state that they will make every effort to carry out the contracts, and that the British Government intends to do everything possible to maintain export trade by assisting contractors, or at least putting no obstacles in their way in the fulfilment of orders.

Utilising " Flight Capital "

At the middle of August it was announced by the spokesman of a group of South African business men that they were planning the flotation of a company with £50,000 capital to assist the investment of " flight money " (political refugee capital) in South Africa. The firm, in which a Transvaal member of Parliament and two retired senior banking officials are principals, was to be called Manufacturing Industries, Ltd. It was to make contact with European industrialists who, though refugees, had got sufficient capital to buy in Europe the necessary machinery to start up small factories. The function of Manufacturing Industries, Ltd., was to be the finding of suitable sites in South Africa for these factories, and to provide the money for buildings and other necessary incidentals to starting production. It had already concluded all arrangements in connection with two industrialists, who were to have left London on September 7th with £20,000 worth of machinery for a canvas factory which is to be, or was to be, opened near Cape Town. At that time the greatest difficulty of the company was that the Union Government appeared to be reluctant to grant permits for " key men " in the industry to come in and out, and in addition the slow methods of the Immigration Board. Now with war raging the difficulty in the way of obtaining permits for the importation of " key men " is of course almost, if not entirely, insurmountable.

Cape Town Water Purification Plant

Preliminary work has begun on the construction, on the mountain slopes overlooking Gordon's Bay, of a £250,000 filtration station for the purification of the major part of Cape Town's water supply, which comes from the Steenbras reservoir between 30 and 40 miles from Cape Town. Up to the present the advent of war has not interrupted the scheme. If the plans as now prepared are carried out to normal schedule, the filtration of Steenbras water should be an accomplished fact within the next three years. At the moment a road two miles long is being constructed leading off the Faure Drive beyond Gordon's Bay up the mountainside to the site of the filtration station near the entrance to the pipe line tunnel. The station will be an imposing structure commanding a magnificent outlook across False Bay. A village of concrete huts to house the 200 workmen who will be employed on the road and the station site is also being constructed on the mountainside. A tender of £5,575 has also been accepted by the Council for the erection of a superintendent's house and quarters for four operators; electric light and power installation is to be provided for these five residences. The road and the site are expected to take a year, while the erection of the station thereafter will probably take two years to complete. The station will have a filtration capacity of 20,000,000 gallons a day, compared with the 3,000,000 gallons which can be dealt with daily at the Kloof Nek station where the Table Mountain water is purified.

Rail and Road

FIRST-CLASS TRAVEL IN LONDON.—The London Passenger Transport Board has decided to abolish first-class travel on most of the train services in the London area, as from the end of January next.

ELECTRIFICATION IN ITALY.—Last year 1100 million lire were spent in Italy on railway improvement works and there are now about 3250 miles of electrified lines in the country. It is now possible to travel from Reggio di Calabria to the Swiss frontier on electrified lines.

NEW RAILWAY IN CENTRAL AFRICA.—Work is in progress on the first 100 kilometres of a new railway connecting Tete with the Central Africa Railway at Dona Ana. When the new railway is completed it will give Tete and the Portuguese territory north of the Zambesi district, *via* the Zambesi Bridge and the trans-Zambesia Railway, direct communication with the port of Beira.

CONTROL OF TRAFFIC LIGHTS FOR HIGH-SPEED TRAFFIC.—At the junction of the Winchester by-pass with the Portsmouth Road a system of automatic signal control for high-speed traffic has been installed to permit the passage of vehicles without reducing their speed. Duplicate vehicle detector pads are installed on the roads concerned, and the control of fast traffic is through pads placed at a considerable distance from the lights.

DYNAMOMETER CAR TRIALS IN INDIA.—A note in the *Railway Gazette* says that the Indian Railways Dynamometer Car Office has, in consultation with the Central Standards Office under the Railway Board, been investigating *inter alia* such subjects as cylinder performance, the reduction of drop in pressure between boiler and steam chest, and the rating of standard locomotives. As a result, it has been decided to prepare designs for modernising one of the Great Indian Peninsula 4-6-0 type engines for exhaustive dynamometer car trials.

PRODUCER GAS BUSES.—The Bristol Tramways and Carriage Company, Ltd., is carrying out a series of experiments in the use of producer gas for motor buses. Four single-deck and one double-deck buses have been fitted with equipment. In three of these buses the fuel hopper is carried in the back of the vehicle and in the other two on a trailer attached to the rear. They run on an average 120–125 miles a day and are said to be operating satisfactorily up to the present. Anthracite is being used as fuel at present, but it is intended to experiment with coke and other fuels.

BATTERY BUSES.—A note in the *Transport World* gives particulars of a report by the general manager of the Cardiff Transport Department on the possibility of using battery vehicles for passenger transport. It is stated that owing to the limited mileage obtained on one charge from a battery of reasonable size, changing over of batteries several times a day would be necessary, and the most convenient method would be to employ a trailer containing the batteries. Assuming the use of a trailer, the performance which would be obtained with batteries of various sizes propelling a bus of standard single-deck, 32-seater design, would be as follows:—(1) Battery cost (pre-war), £350 5s.; capacity, 96 Ah; weight, 2·12 tons; and distance per charge, 9–14·5 miles. (2) Battery cost, £902 5s.; capacity, 288 Ah; weight, 5·65 tons; and distance per charge, 25–42 miles. (3) Battery cost, £1424 5s.; capacity, 480 Ah; weight, 9·32 tons; and distance per charge, 35–56·5 miles. For the first distance-per-charge figure a consumption of 200 Wh per ton-mile and an average speed of 15 m.p.h. are assumed, and for the second 150 Wh and 10 m.p.h.

AMBULANCE TRAINS.—The British railways have completed a number of ambulance trains for use both at home and overseas, the work upon different types of vehicles having been entrusted to the various Companies' Works at Derby, Wolverton, Swindon, Doncaster, York, Eastleigh, and Lancing. Each train is fully equipped with cars for the accommodation of travelling staffs of doctors, nurses, and R.A.M.C. orderlies; wards for lying, sitting, and mental cases, and travelling pharmacies, while kitchens and cars for infectious cases and stores are also provided. Each home train is composed of nine vehicles of seven types, while there are sixteen vehicles of nine different types in each overseas train. All vehicles are 57ft. long, mounted on four-wheeled bogies, and have side buffers, screw couplings, and communicating gangway connections; the couplings and drawgear of the overseas vehicles being of Continental pattern, with special type steam couplings for use with French locomotives. They are steam-heated—each heater being under separate control; while in addition, independent heating is fitted in cars for the staff and personnel, who may be required to live on the train at periods when no steam is available. The Staff cars are provided with bedrooms, dining-rooms, and bathrooms for the medical officers and nursing sisters.

IMPROVED LIGHTING OF MAIN-LINE TRAINS.—The first test of experimental methods for the interior lighting of passenger compartments on long-distance trains during the "black-out" hours, was carried out on the London, Midland and Scottish Railway Company's 4.50 p.m. Euston to Heysham express on Monday, October 30th. The experiment followed intensive research on the part of the railway companies, the Ministry of Transport, and the Home Office. The system tried out can only be applied on main-line trains; the greater number of stops made by suburban trains, together with the universal use of compartment doors on suburban stock, renders it impracticable for application to such services. Separate experiments are, however, being carried out with a view to seeing whether it is possible to provide a better standard of lighting in suburban trains. The standard of lighting tried out on the L.M.S. affords sufficient interior illumination for reading even small type. The opalescent light shades previously used are replaced by black shades which throw the light down directly over the passenger seats, whilst the windows are painted all round on the outside with a 4-in. black border. In addition, close-fitting blinds are installed, which are kept drawn during the hours of darkness. Owing to the difficulty of obtaining the necessary materials it will not be possible to introduce the improved lighting on all main-line trains for several months at least.

Miscellanea

NEW CROYDON POWER STATION.—The Croydon Electricity Committee has obtained consent for the establishment of a new power station and sanction to borrow £326,579 for its construction.

CANADA TO SUPPLY COPPER TO BRITAIN.—Contracts have been placed by this country with Canadian copper producers for 420,000,000 lb. of electrolytic copper to be supplied over an approximate period of one year. Prices will be about that ruling at the outbreak of the war.

UNIVERSITY COLLEGE, LONDON (Department of Chemical Engineering)—In view of the importance of chemical engineering at the present juncture, the Ramsay Laboratory of Chemical Engineering at University College, London, has re-opened, and students will be accepted for training in chemical engineering and research forthwith.

MINERALS CENSUS IN THE UNITED STATES.—The United States Bureau of Mines is to inaugurate a monthly canvas on the production, consumption and stocks of what are termed strategic minerals. This action has been prompted by the need for up-to-date accurate statistics on certain domestic and imported raw materials to assist Government agencies and industry, in meeting the problems of supply brought about by the interruption of shipping as a result of the war in Europe.

SAFETY IN COAL MINES.—A report entitled "Safety Provisions for Underground Work in Coal Mines" has been issued by the International Labour Office in Geneva. In addition to giving statistics in regard to the incidence and principal causes of underground accidents in the mines of some of the largest coal producing countries, it includes a survey of the law and practice in matters of coal mining safety in some of the countries. Other subjects dealt with are means of access and egress, explosives, lighting, fires, shaft sinking, first aid, rescue, etc.

JOINT COMMITTEE ON MATERIALS AND THEIR TESTING.—Under present conditions, the general discussion on "The Properties and Testing of Heat Insulating Materials," organised by the Joint Committee in conjunction with the Institution of Gas Engineers, arranged for November 23rd, has been postponed. It is hoped, however, to revive the discussion when more favourable circumstances prevail. The Institution of Mechanical Engineers, which provides office accommodation for the Joint Committee, has removed temporarily to "The Meadows," Betchworth, Surrey, where the Secretary is available during the day.

WORK OF THE AMERICAN P.W.A.—On June 16th last the Public Works Administration of the United States completed its sixth year of working. During this time 34,450 projects involving a total cost of over 5950 million dollars have been carried out. Of this, 3277 million dollars was federal money, including 1507 million dollars in grants to 16,700 non-federal projects costing 4185 million dollars, and allotments to 17,790 federal projects amounting to 1770 million dollars. Over 25,000 projects have been completed at a total cost of over 3753 million dollars and about 6800 projects with a total cost of about 2 million dollars are now in hand.

STEEL TUBING.—A new steel tubing known as "Agalloy" which has been developed in the United States by the A.G.A Metal Tube Company is described in *Iron Age*. The tubing is produced by joining spirally wound cold rolled strip in a hydrogen atmosphere high frequency induction furnace. Constant pressure is applied to the spiralled strip at the moment of joining and is not relieved until the temperature of the tube has been reduced to below the freezing point of the bonding material. This manufacturing process is claimed to give a perfect joint. The tubing is supplied cold drawn and can be bent, expanded, spun, machined, and welded. It is made in sizes from ¼ to ⅝in. inside diameter with wall thicknesses varying from 0·01 to 0·042in.

PROJECTED STEEL PLANT IN BRAZIL.—It is reported in the *Iron Age* that the United States Steel Corporation and the Brazilian Government are investigating the possibilities of developing the large iron ore deposits in the state of Minas Geras and of establishing a steel making plant for the manufacture of rails and light products. The project is estimated to cost about 30 million dollars and would be financed by the combined efforts of the Brazilian Government and American and Brazilian capital. It would involve amongst other things the improvement of the Government owned Central Brazil railway, the erection of a blast furnace, open hearths, and rolling mills, a guarantee by the Government against future appropriation of the properties and the obtaining of cheap coal. It is expected that representatives of the United States Steel Corporation and a mission appointed by the Government, which has been investigating the Brazilian ore situation, will make a report to the President early next month.

THE NATIONAL CENTRAL LIBRARY.—In times of peace the British Isles has, in addition to a splendid public library service, a system of library co-operation under which all persons requiring books for any serious purpose are able to obtain them through their local public, university, or other library. The keystone of the national system is the National Central Library, which, in addition to being itself a great lending library, is the national centre for the inter-lending of books between one library and another. The organisation of this library, with its great union catalogues and other bibliographical material, and the access it has to over twenty-one million books in other libraries in the British Isles, places it in an exceptional position to give a service of special value in time of war. Owing to the risk of the destruction of property at the headquarters of the Library in London, all the union catalogues, as well as all other irreplaceable or scarce bibliographical material, have been removed to Hemel Hempstead. The non-bibliographical books are remaining at the London headquarters in Malet Place, W.C.1. All applications for books or bibliographical information should be made through the reader's local library, but correspondence on any other subject should be addressed to the National Central Library at Bourne Lodge, Bourne End, Hemel Hempstead, Herts. In cases of difficulty the Librarian will gladly give information about the source from which books may be obtained on loan.

Air and Water

THE DIRECTOR OF SHIPBUILDING.—The Minister of Shipping has appointed Sir Amos L. Ayre to be Director of Shipbuilding and Repairs in the Ministry of Shipping.

DOCK WORKERS' WAGES.—The National Joint Council for Dock Labour has agreed that dock workers' wages are to be raised throughout the country by 1s. a day, as from November 13th.

CONTRABAND CONTROL.—During the first eight weeks of the war, to October 28th, the British contraband control organisation intercepted and detained over 400,000 tons of goods. The French organisation had seized about 150,000 tons up till October 12th.

DEATH OF SIR FRANK NOTLEY.—The death is announced of Captain Sir Frank B. S. Notley, who was marine superintendent of the P. and O. Line from 1917 to 1929. He entered the service of the line in 1886 as a junior officer, and obtained his first command in 1905. He was also a Younger Brother of Trinity House.

SHIPBUILDING IN SPAIN.—The Spanish Government is making an effort to restore its mercantile marine, and a recent decree authorises it to grant loans up to 60 per cent. of the value of the ships to any firm having vessels built in Spanish yards. About 758 million pesetas have been set aside for the granting of the loans.

FAST TRIP BY CANADIAN DESTROYERS.—What is thought to be a record trip of seven thousand miles has been made by two Canadian destroyers. The ships were stationed at Esquimalt, B.C., and on two hours' notice set out for the Atlantic seaboard. In spite of a day's delay in making transit of the Panama Canal and other stops en route the distance was covered in fourteen days.

THE ST. LAWRENCE POWER SCHEME.—It is stated in the Canadian press that there are strong indications that the Canadian Government will immediately re-open negotiations with the United States for the joint development of the St. Lawrence River as a new source of hydro-electric power, but it is not yet ready to make a formal announcement. More than 1,000,000 H.P. could be obtained from the St. Lawrence.

PROPOSED AMERICAN NAVAL EXPANSION.—The chairman of the United States House of Representatives Naval Committee has announced that authority is to be sought from Congress for a new naval expansion programme costing 1300 million dollars. It is proposed to build three aircraft carriers, eight cruisers, fifty-two destroyers, thirty-two submarines, a number of auxiliary vessels, and about 2400 more aeroplanes.

HUNGARIAN HYDRO-ELECTRIC SCHEME.—The Hungarian Government has begun work on the completion of two hydro-electric power stations north of Ungvar which were begun in 1924 by the Government of Czechoslovakia. According to *The Electrician* the river Ung is to be dammed near the village of Okemence, and its waters will be diverted through the mill-race, some 10 km. in length, built in 1870, rejoining the bed of the river above Ungvar. The two stations on the mill-race will have an average capacity of 2400 kW each, while their peak load will vary with the head of water available between 320 kW and 4200 kW. An annual output of 20,000,000 kWh is expected.

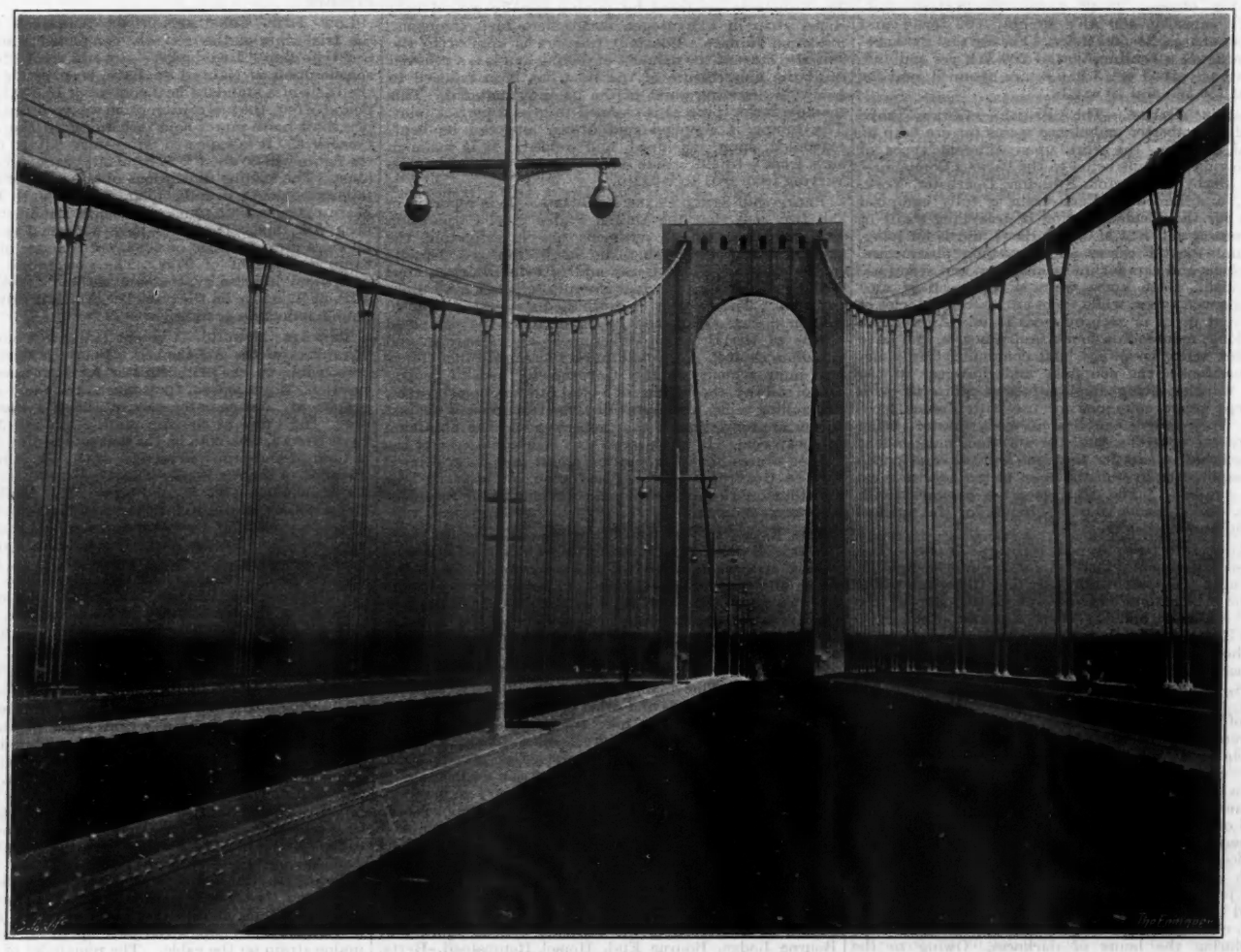
LOW FUEL CONSUMPTION OF AMERICAN SHIP.—At the trial runs of the recently completed United States C–2 type ship "Red Jacket" a world record for low fuel consumption is claimed to have been established. On the basis of a standard heat content of 18,500 B.Th.U. per pound of fuel, the fuel consumption was recorded as 0·545 lb. per shaft-horse power-hour according to the *Journal of Commerce*. It is expected on average day to day service the figure will be about 0·57 lb. of oil per shaft-horse power-hour. The leading dimensions of this type of ship are as follows:—length overall, 459ft. 2½in., length b.p. 439ft., beam extreme 63ft. 2in., and depth moulded to shelter deck 40ft. 6in. The ships have a normal speed of 15½ knots, a gross tonnage of 6085, net tonnage of 3573, and cargo deadweight of 9758. The power unit is a cross compound impulse type steam turbine developing 6000 H.P. at 92 r.p.m. on the propeller, which it drives through double reduction gearing.

THE AIR COUNCIL.—A recent Order in Council defines the duties of the Air Council. Four members are to be responsible to the Air Minister for the command, disposition, organisation, personnel, training, equipment, armament, and maintenance of the Air Force. These are: The Chief of the Air Staff, Air Chief Marshal Sir Cyril Newall, who is to be the first and Senior Air Member of Council and principal adviser of the Air Minister in the direction of the Air Force; The Air Member for Personnel, Air Vice-Marshal C. F. A. Portal; The Air Member for Development and Production, Air Marshal Sir Wilfrid Freeman; and the Air Member for Supply and Organisation, Air Vice-Marshal W. L. Welsh. The Parliamentary Under-Secretary of State for Air, Captain H. H. Balfour, who is vice-president of the Council, will be responsible for business assigned to him by the Minister. The Permanent Under-Secretary of State for Air, Sir Arthur Street, will be responsible for financial advice and will also be designated secretary of the Council.

AIR MAIL FOR SMALL AMERICAN TOWNS.—The method which has been adopted for the delivery and collection of mail by aeroplane in a number of small towns in the United States is described in a recent issue of the *Scientific American*. At each of the towns the ground equipment consists of two steel poles 30ft. high and 60ft. apart, each being topped with a brilliant orange marker. Stretched between the poles and attached by spring clips is a transfer rope from which is suspended the mail bag to be picked up. The aeroplane passes over the poles and a pick-up cable from it slides across the transfer rope until a grapple engages and pulls it from the poles. As the grapple pulls on the transfer rope the mail bag slides along the rope from the grapple until it is checked near the end of the rope. This slide fitting absorbs much of the shock of contact and enables the pick up to be made without undue strain on the cable. The remainder of the shock is taken up by absorbing mechanism in the aeroplane. The delivery bag is dropped from the machine just before the pick up is made.

BRONX-WHITESTONE BRIDGE, NEW YORK

(*For description see page* 462)



TOWER AND ANCHORAGE ON QUEENS SIDE OF EAST RIVER
DOUBLE ROADWAY ACROSS BRIDGE

The Engineer

NOVEMBER 10, 1939

VOL. CLXVIII No. 4374

Contents

THE ENGINEER, November 10th, 1939 PAGE

A SEVEN-DAY JOURNAL ... 461

LEADING ARTICLES—
THE RIVAL FIGHTERS ... 473
HOME PRODUCED FUEL FOR ROAD VEHICLES ... 473

SPECIAL ARTICLES—
BRONX-WHITESTONE SUSPENSION BRIDGE. No. I. (Illus.) 462
PROJECTED EXHIBITS AT OLYMPIA. No. IX. (Illus.) ... 475
REMOTE SUPERVISORY CONTROL. No. I. (Illus.) ... 464
SCOTTISH LOCOMOTIVE EXPERIENCES. No. VIII. Part I. (Illus.) ... 467
FUEL TECHNOLOGY AND THE WAR ... 469
HIGH SPEED LIGHTWEIGHT TRAINS. (Illus.) ... 479
IRON AND STEEL PRODUCTS CONTROL ... 481
SOUTH AFRICAN ENGINEERING NOTES ... 470

LETTERS TO THE EDITOR—
CORROSION OF GEAR TEETH ... 474
SCOTTISH LOCOMOTIVE EXPERIENCES ... 474

LITERATURE ... 474

OBITUARY—
C. H. COLSON ... 474

NEWS AND NOTES—
AIR AND WATER ... 471
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 484
FORTHCOMING ENGAGEMENTS ... 484
FRENCH ENGINEERING NOTES ... 484
MARKETS, NOTES AND NEWS ... 483
MISCELLANEA ... 471
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 484
RAIL AND ROAD ... 471
SIXTY YEARS AGO ... 474

ANNOUNCEMENT

With a view to the conservation of paper readers are advised, in the interests of all concerned, to place a regular order for "The Engineer" with their newsagent or direct with the Publisher.

NOTICE TO READERS

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

*** *For Subscription rates, see page 2 of Advertisements.*

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGE OF ADDRESS

*** *Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Postal Address : "The Engineer," 28, Essex Street, Strand, London, W.C.2.

Telegraphic Address : "Engineer Newspaper, Estrand, London."
Telephone : CENtral 6565 (10 lines).

THE RIVAL FIGHTERS

ALTHOUGH to many people the War in the Air has, so far, proceeded on lines they did not at all expect, to others, among them some of the closest students of the art of war, what has happened is very much what would have been anticipated. But to all observers alike the full demonstration of the relative strength of attack and defence has yet to be revealed. Many believe that defence must win in the end, but how soon that will happen must depend upon the intrinsic fighting efficiency of the opposing aircraft and upon the alert watchfulness of the warning organisations on the two sides.

An essential requirement of any intercepter fighter is that it shall in the first place be fast enough to intercept any enemy bomber, and although this simple sounding requirement appears to be readily provided by a really clean fuselage and a sufficiently powerful engine, the work of the aircraft designer is by no means as simple as that. The intercepter fighter has to fight as well as to intercept; fighting means rapid manœuvring, and rapid manœuvring creates those high inertia loads on the wings which, especially in really fast aircraft, are liable to give trouble. For one thing, any rise in design speed brings about an equal rise in inertia stress when carrying out manœuvres. No matter how skilled the pilot, all aerobatics are bound to produce very high loads, as when pulling suddenly out of a dive or when making rapid turns. In anything of the nature of an air melée or "dog fight," rapid turning is essential, and the successful aircraft in such a contest is likely to be the one having, whilst under full control, so wide a range of speed that close turns are possible. But even this is very far from being the whole story. In some types of aircraft with very highly laden wings, the airflow over the wing surface, particularly, it appears, in the case of the tapered wings so generally popular, is liable to change its form quite suddenly and not on both wings at the same instant. When this happens it may lead to catastrophic stalling at the wing tips. Aeroplane designers have different ways of guarding against this, though, may be, at some cost in other directions. The precisely right balance between these, often contradictory, requirements is a matter of highly skilful choice, and it is here that long experience backed by the best scientific knowledge available comes into play. Neither practical knowledge nor scientific information alone suffices; it is the intimate combination that is essential. It may well be that the notorious lack of pursuit by the Nazi authorities, in recent years, of scientific investigation will here, as elsewhere, call for a heavy price to be paid. Be that as it may, it does certainly appear from the evidence available that our intercepter fighters are substantially better than the German. The Messerschmitt has a well-deserved reputation for high speed, but it is reported as seriously deficient in manœuvring power; indeed, it is stated that on a rapid turn it is liable to get out of control altogether, and when that happens, at such high speeds, structural failure is likely enough to follow. But short of actual break-up in the air, it is manifest that any such instability must make it an unreliable fighting machine for even the most experienced pilots to handle; and the longer the war lasts the less will be the numbers of experienced pilots available. This uncertainty of response to the aircraft controls, bad as it is in fighting manœuvre, is also a serious disadvantage in taking off, and still worse in landing, especially at night.

Perhaps we have said enough to demonstrate how many are the difficulties that lie in the path of the successful designer of an intercepter fighter, and to claim, from the result of actual fighting, that the honours are at present with the British designer. That this is so is borne out by a recent broadcast address by an observer with the R.A.F., in France, in which it was suggested that the poor performance of enemy intercepters may account for the extraordinary freedom from attack of our pamphlet raiders when on their night flights over Germany, though there is no doubt another explanation of this unexpected occurrence, namely, that our aircraft may have remained undetected during these flights, which would be indeed strange if it were true.

Home-Produced Fuel for Road Vehicles

WITH petrol rationing already in force and a possibility, though fortunately no probability, that a further limitation may have to be enforced, it is not surprising that a greater interest has begun to be taken in vehicles constructed or equipped to use fuels other than petrol or diesel oil. The development of such vehicles has been encouraged for several years by the governments of a number of European countries with the object of reducing the dependence of the respective nations on an imported fuel, and more especially in France and Germany considerable progress has been made. In this country, although somewhat onerous taxation and speed limit restrictions have retarded practical development, the necessary technique has been studied, a large amount of experimental work has been carried out, and a number of firms have undertaken the manufacture of equipment. But until recent months, when the likelihood of war breaking out became large, the problems seem to have been regarded as somewhat academic and few suitably equipped vehicles were actually on the roads of this country. Now, however, investigation has been intensified and the possibilities of several fuels alternative to petrol and imported oil are being studied.

Among the more important varieties of fuel available are producer gas, coal gas, methane gas, as obtained from the digestion of sewage, coal dust, and steam raised in coal-fired boilers. Of these fuels the two latter suffer the disadvantage under present circumstances that they require specially designed engines and cannot therefore be used in existing vehicles. Coal dust, moreover, has not yet achieved commercial success as a fuel even in comparatively slow-running stationary engines, and is thus scarcely likely, at least for some time to come, to be used successfully in motor vehicles. Coal gas was used at atmospheric pressure for the propulsion of vehicles during the last war and many will no doubt remember seeing saloon cars surmounted by bags of balloon fabric in which the gas was contained. Used in this way, however, coal gas, which can be burnt satisfactorily in engines designed for petrol, suffers the disadvantage that as much as 250 cubic feet of gas are required to give a mileage corresponding to a single gallon of liquid fuel. The height of the vehicle is thus increased by the large gas-bag whilst the range of action is severely restricted by the impossibility of carrying more than a small supply of fuel. The same argument does not apply to compressed coal or methane gas, nor to producer gas. These fuels are those towards the use of which the greater attention is at present being given. Several experimental vehicles have been fitted in this country for running on compressed gas and the practicability of the system on technical grounds has been fully demonstrated. Recently the Middlesex County Council approved a scheme for using surplus methane gas from sewage sludge digestion for the operation of its motor transport vehicles. The eventual sale of gas to the London Passenger Transport Board and perhaps also to haulage contractors is envisaged. For general purposes, however, gas stored in this way has certain disadvantages. A number of somewhat heavy steel storage cylinders has to be carried, and up to date the Government has insisted that the weight of the cylinders shall be added to that of the unladen vehicle for taxation purposes, thus tending to place a vehicle equipped to use compressed gas in a higher taxation class. Moreover, unless a large number of cylinders is carried the radius of action is restricted whilst, at least at present, the availability of cylinders and the necessary compressing plant is far from widespread. In addition, whilst steel is urgently required for the needs of the fighting services, there is some doubt as to how much could be made available for the fabrication of cylinders. As the cost of the fuel appears to be sensitive to the demand on the compressor plant, rising somewhat steeply, according to calculations made by the National Gas Council of Great Britain and Ireland, in small plants, unless regularity of the filling of vehicles can be guaranteed, this fuel appears to be better suited to municipally owned transport systems than to the less regular operations of general haulage contractors. For the latter service attention has been concentrated particularly on the use of producer gas, and in Germany and France several thousands of vehicles were already in use before the outbreak of war. Plans are now being made for large developments in this country, and the L.P.T.B. and the Bristol Tramways and Carriage Co., amongst others, are experimenting with plants drawn on two-wheeled trailers behind omnibuses. Permission for the use of such trailers has been granted by the Minister of Transport. Development of the producer gas vehicle, though government encouraged, particularly in France, has not been very rapid. The producer gas vehicle, like that running on compressed gas, suffers the disadvantage that an additional weight of equipment must be carried about. Many difficulties had to be overcome before the producer plant could be regarded as satisfactory. The technique of gas production has now, however, been fully developed and remaining difficulties centre around the use of such fuels as bituminous coal. Hard wood charcoal, coke, and anthracite introduce

relatively few troubles. When, however, bituminous coal is used tar is distilled out in the process and although filters have been developed which have proved highly successful in large industrial producer gas plants no really satisfactory small filter suitable for motor vehicles seems yet to have been devised, although a number in course of development show great promise.

Abroad, particularly in France and Germany, as has already been mentioned, the development of vehicles capable of running on home-produced fuels has been the subject of government encouragement, whereas in this country, whilst government approval has been given, no practical incentive to development has been granted by the removal of irksome taxation and other restrictions. Nevertheless, this country has not lagged behind. It was here in 1901 that the Parker brothers took out the first important patents for producer gas for road transport, and from a period towards the end of the last war, when the scarcity of petrol encouraged research, development has been continuous. A certain number of gas-propelled vehicles are already on our roads and the number is likely rapidly to increase. It is, however, doubtful whether under any but the exceptional circumstances of war the converted petrol vehicle could be regarded unreservedly as successful. For even when the engine is modified by the raising of the compression ratio as far as may be without imposing too severe stresses on the mechanism there is some loss of power and performance. Various means of overcoming this disadvantage have been proposed, notably that of carrying a small amount of petrol and introducing it in small quantities whenever there is a demand for extra power. But the use of two fuels is to some extent itself objectionable and unsatisfactory. It is, therefore, perhaps probable that in the near future, providing that the war shows no sign of coming to an end, new vehicles will be constructed particularly for running on producer gas or compressed gas rather than petrol. If that should prove to be the case the claims to attention of the steam vehicle ought not to be neglected. For many years "steamers" were a common sight on our roads and their eventual banishment was brought about by onerous statutory regulations rather than by any technical failure. Unlike the producer gas vehicle, the "steamer" is not sensitive to changes of fuel and any reasonably good coal can be burnt beneath its boiler. If vehicles are to be specially built to burn home-produced fuels many operators, we believe, might choose the "steamer" rather than the gas-producer vehicle.

Obituary

CHARLES HENRY COLSON

On Sunday, October 29th, the death took place, following a short illness, of Mr. Charles Henry Colson, who retired in 1926 from the office of Deputy Civil Engineer-in-Chief of the Admiralty. Since his retirement Mr. Colson had lived at his home, Harbour Bar, Old Fort Road, Shoreham-by-Sea, where his death took place at the age of 75 years. He came of an engineering family, and his father, the late Mr. Charles Colson, was also in Admiralty service and joined the Admiralty in 1866, retiring as Deputy Civil Engineer-in-Chief in 1905. He was the author of a standard work on Dock Construction.

Charles Henry Colson was born in 1864, and received his education privately at Portsmouth. In 1884 he joined the Admiralty Civil Service, and was posted to the Department of the Civil Engineer-in-Chief. He received his practical training at Portsmouth Dockyard, and was subsequently engaged, under his father's department, in work on Admiralty dock construction and design, and on general civil engineering work in the Royal Dockyards and Admiralty works both at home and abroad. He saw service at Portsmouth, Dover, and Plymouth, and abroad at Malta, Jamaica, Ceylon, and Singapore. New docks with which he was intimately associated were those at Portsmouth, Malta, and the completion of the Admiralty breakwater at Dover. In collaboration with his father, he presented a paper on the Malta Harbour works and the Hamilton Graving Dock to the Institution of Civil Engineers during the Session of 1893–1894. In this paper the construction of the dock and the 160-ton hydraulic crane, which was employed for the Malta dock extensions, is fully described, and an account is given of the tests which were carried out on the Portland cement used and the performance of the Lobnitz rock cutter which was employed in the work of excavation. In 1914 the services of Mr. Colson were lent to the Greek Government for a period of three years as a member of the Naval Mission to Greece, and his work for the Greek Government was recognised by the honour of the Order of Commander of the Order of the Redeemer, Greece. Mr. Colson was elected an associate member of the Institution of Civil Engineers in February, 1890, and was transferred to full membership in February, 1901. He was also a Fellow of the Royal Sanitary Institute.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

CORROSION OF GEAR TEETH

Sir,—I wonder whether one of your readers can explain the following phenomena to us. We have a 50-H.P. Rubber Calendar driven by electric motor at 950 r.p.m. The first reduction gear is an all-enclosed double helical gear running in oil. As far as we know, this oil is of first-class quality. On taking the gear adrift after six months' use, for examination, we find that the teeth are badly pitted, just as though they had been exposed to some corrosive action. The secondary gear, running at one-sixth of the speed of the motor, consists of two plain machine-cut mild-steel pinions, reduction ratio 1·8 to 1. This is lubricated with an entirely different grade of oil, and is, in fact, exposed to the atmosphere, although the latter is not corrosive. We find these teeth are also pitted, although to a lesser degree than those of the primary gear. There is no indication that the plant is overloading. In fact it usually runs around 25 to 30 H.P. at most. Is there any logical explanation for the pitting of gear wheel teeth ?

P. K. Saunders,
Chairman, Saunders Valve Company, Ltd.

Newport, October 31st, 1939.

SCOTTISH LOCOMOTIVE EXPERIENCES

Sir,—Readers of these articles may have gathered an exaggerated impression of my objections to the hard seats found on the majority of British engines. May I explain that some, at any rate, of my querulousness has been of the nature of poetic licence—it had a humorous intent ? I do like cushions, but they are not absolutely essential, and I can rub along without them. Fortunately—I have generally had to. But a letter from Mr. Stanier sheds light on the matter, and puts things much better than I could, so I will quote it.

"The comparisons you made in reference to drivers' and firemen's seats were perfectly legitimate, and whether we fit 'hard bottoms' or 'soft bottoms' is more a matter of custom than anything else.

"It is only since I have been on the L.M.S. that there has been any general fitting of seats on locomotives at all, and even now many of the drivers do not use them. The British working man is a very conservative creature, and I remember years ago, when cab roofs were introduced instead of a weatherboard, one of the old drivers who had retired, on seeing them, remarked, 'there won't be any red-faced 'uns now!'"

It will be understood, then, that my criticism has been purely personal—if the enginemen are satisfied, I withdraw my amendment. But may I gently hint, "in the politest manner in the world," that I have never noticed any crew resisting the blandishments of the comfortable bucket seats found on modern L.N.E.R. engines ? I can never ignore them either—evidently I must have an exceptionally "soft bottom!"

E. H. Livesay.

Literature

SHORT NOTICES

Electrical Engineering Experiments: Theory and Practice. 1939. By Henry R. Reed and George F. Corcoran. London: Chapman and Hall, Ltd. Price 12s. 6d.—Designed as an aid to instruction in electrical engineering laboratories, this book meets the needs of electrical engineering students. The text is divided into seven sections, namely, fundamentals, D.C. machines, A.C. circuits, transformers, synchronous machines, induction machines, and electronics. In the Introduction, general information and instructions pertaining to laboratory technique, report writing, and the theory of instruments are presented. The material covered in the fundamentals section is that which is usually given to the beginning student in the sophomore year. In the section on electronics some of the fundamental properties of valves are considered, although in the main no reference is made to electronic applications in the power field. To enable the student to grasp the significance of exercises and to perform them without detailed reference to other books, ample theory is given with each experiment, and in very few, if any, additional laboratory instructions are required. The text is based on the authors' experience at the University of Minnesota, Kansas State College, South Dakota State College, the test floors of the Westinghouse Electric Manufacturing Company, the Electric Machinery Manufacturing Company, as well as the Michigan College of Mining and Technology and the State University of Iowa.

Refractories for Furnaces, Kilns, Retorts, &c. By A. B. Searle. London: Crosby Lockwood and Son, Ltd., Stationers' Hall Court, E.C.4. Price 3s. 6d. net.—This book describes the characteristics of the principal raw and manufactured refractory materials and the processes employed in their production. After dealing generally with raw refractory materials, the various sections of the book deal with the colour, shape, size, texture, composition, properties, &c., of the different types of bricks including fireclay, silica, kieselguhr, sillimanite, bauxite, magnesia, chromite, zircon, carbon, and carbide. Special chapters are devoted to refractory hollow ware, tamped linings, and cements, and the selection and application of refractory materials. For its size, the book covers a wide field and will be a useful addition to the practical literature on the subject upon which Mr. Searle is an authority.

Sixty Years Ago

The "Grosser Kurfurst"

On May 31st, 1878, the German ironclad "Grosser Kurfürst" was rammed and sunk by her consort the "König Wilhelm." The disaster occurred about three and a half miles south-west from Folkestone. The vessel sank within six or eight minutes of being struck, and although some of the crew were saved, many were lost. In the following July, The Wreck Recovery and Salvage Company undertook to raise the vessel. She was lying bottom upwards in eighteen fathoms. The plan of operations consisted first of fitting a shield over the rent in her side and then of forcing the water out of her by air in such a manner that she would rise to the surface in the inverted position. It was anticipated that the vessel might cant while coming up and allow the air to escape and the ship to sink once more. To provide for this possibility, a number of collapsible "pontoons" in the form of cylindrical bags made of india rubber and canvas, and having displacements when inflated of from 10 to 40 tons, were to be attached in a row along the ship's keel, the intention being that they should be inflated when in position under the water. Many difficulties had to be overcome before all was ready for a trial. A minor one consisted of the difficulty of attaching a line to the ship's inverted hull for the purpose of hoisting the shield into position over the hole in the hull. This difficulty was surmounted by the divising of semi-spherical "suckers," round the mouths of which soft india rubber rings were placed. Each sucker was provided with a small suction pump, a few strokes of which were sufficient to make the sucker cling to any position on the hull to which it might be applied by the diver. The pressure of the external water, it was stated, caused the sucker to adhere with a force corresponding to a pressure of about 45 pounds per square inch. Two such suckers were fixed about 10ft. above the collision hole and by means of a three-legged derrick suspended from them the shield was lifted into position from the bed of the sea. An especially made hydraulic shearing machine was provided for cutting the rigging of the sunken ship in order to free the hull of some of the hamper holding it down. In our issues of November 7th and 21st we gave particulars of the salvage equipment. In the second named issue we stated that all preparatory operations for the raising of the vessel had been almost completed. The work was being carried out under the personal supervision of the designer of the recovery equipment, Mr. S. W. Maquay, "a gentleman not only possessing considerable skill as an engineer, but himself a practical diver of great experience and consummate physical endurance." . . . Turning to our issue of December 19th, 1879, we find a short note in which it is recorded that up to that date the ship had not been raised. A series of minor mishaps, mostly mysterious, had, it seems, occurred, and the luckless company had to face the fact that on December 31st its contract with the German Government for the raising of the ship would expire.

Projected Exhibits at Olympia

No. IX

(*Continued from page 454, Nov. 3rd*)

BELOW we conclude our description of some of the exhibits which were to have been shown at the Engineering and Marine Exhibition at Olympia, London, the holding of which has had to be postponed on account of the war.

Hydran Products, Ltd.

Oil burners suitable for all kinds of process work, varnish boiling, continuous kilns, furnaces, central heating, and so forth were to have been shown by Hydran Products, Ltd., of Kings Bourne House, 229–231, High Holborn, London, W.C.1. The range comprises three models, known as the "Standard," the "Major," and the "Magna," with capacities for burning 1 to 5 gallons per hour, 3 to 10, and up to 30 gallons per hour, respectively. The last-named type is furnished with a new design of burner head, which enables more fuel to be burnt and increases the capacity of the "Major" equipment to the amount stated above, and requires an independent air feed; in all other respects it is similar to the "Major" burner.

Particularly interesting at the present time is the claim made by the firm that this range of burners is able to burn without any special preparation the heaviest fuel oils and all sorts of combustible liquids such as used engine oil, copal oils, and wastes of all sorts.

In the accompanying engraving, Fig. 186, a part sectional view of the equipment is shown. It will be observed that the unit is totally enclosed. Connection to the fuel line is by a flexible hose supplied with the unit and attached to a universal connection fitted to the top of the pump casing. The chief components comprise a fuel pump, a fan, and an atomising cone, driven by a ½ H.P. Crompton-Parkinson motor rated for continuous duty. The current consumption of the "Standard" burner is stated to be about 250 watts at full load, and that of the "Major" 600 watts at full load. The fuel pump is of the valveless rotary type, designed to give an infinitely variable flow. It is driven through a 6 to 1 helical steel-fabric gear, housed in an enclosed gear-box. It forces oil under pressure through the hollow spindle A of the motor to the atomising cone B. In order to regulate the supply in accordance with the load requirements a regulating mechanism is embodied in the pump, consisting of a ball-bearing cam device, which moves the pump casing bodily sideways, thus varying the eccentricity of the pump rotor with respect to the casing, and altering the effective volume of the pump chamber.

Oil delivered by the fuel pump passes along a horizontal pipe C, termed the "stationary feeder," which has a quick left-hand thread cut on the outside. This thread acts as an oil-retaining seal, the rotation of the hollow motor-shaft carrying the oil forward, up the thread and through the motor-shaft. A screwed plug D is provided behind the stationary feeder, enabling the feeder to be withdrawn and the hollow spindle to be cleaned. Fuel passing through the hollow spindle emerges at the far end and is thrown on to the inner surface of the conical tube or cup B, which rotates with the fan. The contour of the cone is such that the oil is thrown off at the outer end as a fine film which enters the air blast where it is atomised and intimately mixed with the air.

The fan rotor is built up in aluminium in order to minimise the weight and the inertia load when starting up, and is carefully balanced, both statically and dynamically. It runs within a cast iron casing, the rear end plate of which is provided with ports for the intake of primary air. The opening of these ports is regulated by a shutter-plate, mechanically coupled to the lever controlling the metering fuel pump. The front half of the fan casing has integrally cast air-flow reversal blading, the purpose of which is to cause the direction of rotation of the air-blast to be in the opposite sense to that of the oil film, thus contributing to good atomisation and mixing of fuel and air.

For certain industrial applications a cone-shaped casting which protects the burner when shut down, and also acts as a pre-heater for the secondary air, can be fitted at the forward end of the unit. Secondary air is usually admitted through a damper in the base of the combustion chamber. The complete unit stands in a cast iron drip tray and is furnished with three mounting bolts with lock-nuts, so as to be readily installed.

These burners can be arranged either for manual or fully automatic operation. With manual control, the single control lever enables both fuel and primary air to be regulated simultaneously, in accordance with the readings of pressure gauges or thermometers. For automatic control, however, which, of course, has many advantages, a complete system has been developed by the firm so that temperature conditions can be maintained accurately at predetermined values, without attention.

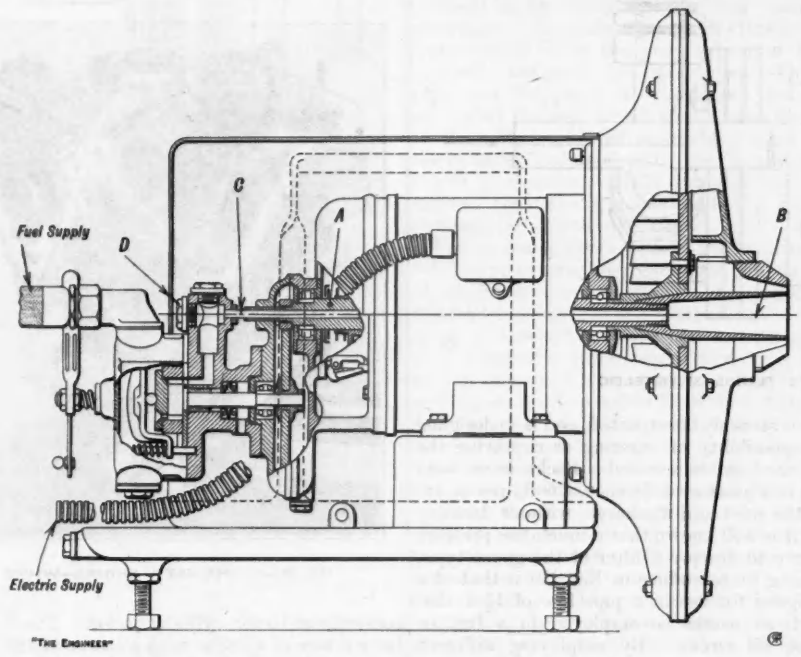


FIG. 186—OIL BURNER—HYDRAN

Silentbloc, Ltd.

Rubber and metal bushes and couplings would have been shown on the stand of Silentbloc, Ltd., of Victoria Gardens, Ladbroke Road, Notting Hill Gate, London, W.11. It is claimed that there are few branches of industry in which such components are not used to eliminate wear by preventing metal surfaces from coming into frictional contact, and in support of this claim a wide range of sizes of Silentbloc bushes, suitable for sustaining loads varying from 10 lb. to more than 6000 lb., would have been exhibited. As is probably well known to many of our readers, these bushes consist of two concentric metal tubes between which there is an insert of stretched rubber.

Anti-vibration mountings in sizes supporting weights of a few ounces up to as much as 8 tons would also have been shown. These mountings, together with bushes of the type mentioned above, would have been shown to advantage upon a large working model of a coal screen, which when in operation would have indicated the high degree of flexibility attainable. The model is illustrated in the accompanying engraving (Fig. 187).

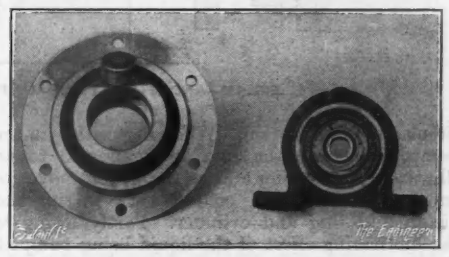


FIG. 188—GLAND AND BALL RACE BEARING—SILENTBLOC

The firm's flexible couplings are of two types, and a range of sizes would have been shown of each. Both are designed to give flexion in all directions, but in the case of one series the arrangement of the Silentbloc bushes is such that thrust can be carried as well as the usual torsional load. This type of coupling is particularly suitable for carrying propeller thrust in marine service. Plummer blocks and ball races mounted on rubber are other interesting developments. On the right-hand side of Fig. 188 is illustrated a ball race having a rubber annulus inside, and on the left a bulkhead gland with a rubber insert.

One of the most interesting exhibits technically

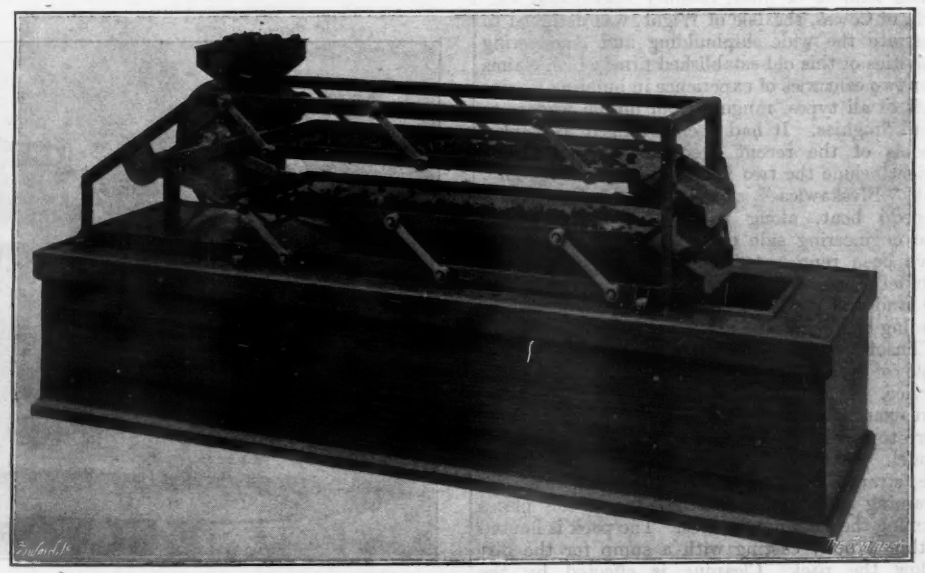


FIG. 187—WORKING MODEL OF COAL SCREEN—SILENTBLOC

would have been the Andre-Hutton pump, shown driven by a ¼ H.P. motor. This pump, designed to handle sandy and gritty fluids, is of the reciprocating type, but no metal-to-metal parts are in frictional contact, for the pistons are sealed by means of an oil-resisting rubber ring to which the piston imparts a rolling motion. We show in Fig. 189 a sectional view of the pump. It is designed for a delivery of 500 gallons per hour against a head of 25ft. and a suction lift of 14ft. It is entirely self-priming and no foot valve is needed.

The bore of the pump cylinder is concave in horizontal section, the outside of the piston being of similar section. Between the two surfaces a rubber ring is interposed, which in its free state is circular in cross-section. When in position in the pump, as shown, the ring is compressed to an elliptical cross-section and as the piston moves to and fro there is rolling contact between ring and piston and ring and cylinder. Partly owing to the lubricating effect of the liquid being pumped, the wear, the makers claim, is practically negligible, while the ring provides a water-tight joint without the use of glands. The inlet and suction valves, which are of the mushroom type, are made of rubber and the tension in the stem is used instead of springs to return the valves to their seats. A thin plate is moulded into the head of the valve in order to give increased stiffness, but the face is rubber only. With this construction it has been found that even large pieces of grit or other foreign matter, which may be held in suspension in the liquid being pumped, are passed without damage to the seat. The pipe unions shown are of the company's special rubber-sealed pattern.

It will be apparent from the drawing that the design is such that no oil or grease can come into contact with the liquid pumped. This being so, drinking water can be pumped without fear of contamination. By using synthetic rubber for the rings and the valves it is possible to pump oil and other liquids without seriously affecting the life of the rubber parts of the pump.

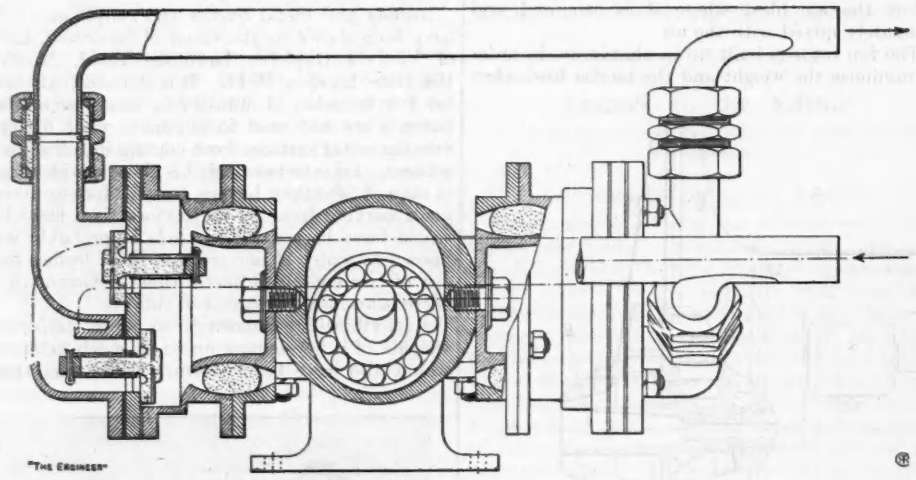


FIG. 189—ANDRE-HUTTON PUMP FOR GRITTY FLUIDS—SILENTBLOC

J. Samuel White and Co., Ltd.

The exhibit of John Samuel White and Co., Ltd., of Cowes, the Isle of Wight, was designed to illustrate the wide shipbuilding and engineering activities of this old-established firm, which claims over two centuries of experience in building marine craft of all types, ranging from flotilla leaders to small dinghies. It had been arranged to display models of the recent productions of the firm which include the two Polish destroyers "Grom" and "Blyskawica" and a model of a motor torpedo boat, along with other ship models. The engineering side of the firm's work was to have been represented by examples of the "J. Samuel White" low pressure oil-burning system for land and marine services, examples of turbine blading of the impulse and reaction types, and the "Clinsol" strainer, which incorporates the principle of edge straining and can be cleaned in service. The strainer is supplied in various sizes, and examples ranging from ⅜in. up to 3⅜in. bore were to have been on view, along with a working model. As will be seen from drawing, Fig. 191, the strainer consists of a cylindrical pack of straining plates, the spaces between the plates forming the straining orifices. The pack is housed within a body casting with a sump for the dirt below the pack. Cleaning is effected by the means of knives which are so disposed as to deposit the debris in a place in the pack, exterior to which there is no flow to the slots, thereby reducing the risk of entraining again the finer particles of refuse. As the diagram of cleaning operations which is reproduced to the left of Fig. 191 clearly shows, the relative movements of the pack in relation to the fixed knives are such as to force the dirt into a space in the pack in the form of a long channel in the face. By means of packing pieces a zone of no flow is provided in this space. A stop prevents the complete rotation of the pack, but it is placed in such a position that the knives partially emerge from the slots so that the reverse motion, illustrated in the third figure of the cleaning diagram, dislodges the accumulation of dirt from the knives and allows it to drop down the channel to the sump. The pack is strongly constructed, and is so designed that any possibility of bursting or rupturing the straining medium is avoided. Packs have been tested up to a pressure difference of 60lb. per sq. in. between the inlet and discharge, without damage, although it is well known that a much less pressure would serve to destroy a filter of the gauze type. The drawing we reproduce in Fig. 191 is that of a filter designed for use in a pipe line of 1½in. dia. bore, such as would be employed in a fuel or lubricating oil circuit. By employing different thicknesses of packing pieces between the straining plates, the strainers can be adapted to different duties and outputs. The strainers we have described are made in sizes from ⅜in. pipe bore up to 4½in. pipe bore for suction and discharge circuits when using oil fuels, oil engine lubricating oils, or turbine lubricating oils.

The oil engine department of the firm was to have been represented by examples of oil engines for the propulsion of both large and small high speed craft.

For the larger craft an engine of the Vimalert pattern, with a designed output of 400 S.H.P. at 1700 r.p.m., was to have been shown, while for the smaller craft there was to be on view examples of the White-Ford engine, with a designed output of 75 S.H.P. at 3200 r.p.m. Both of these engines are designed to utilise petrol fuel. The photographs of the 400 S.H.P. Vimalert engine, which are reproduced in Figs. 190 and 191, show the side and end views of the unit. The engine is manufactured by the Vimalert Company, Ltd., of Jersey City, New Jersey, the United States, and the firm of John Samuel White and Co., Ltd., is the sole selling agent for these engines for the British Isles. In addition to the engine we illustrate there are two other models of generally similar construction with outputs of 800 S.H.P. and 1200 S.H.P. respectively, a range of power from 400 up to 1200 S.H.P. being covered by the series. The crankcase is made from aluminium alloy of high tensile strength, while the crankshaft, connecting rods, gudgeon pins, and valves are made of heat-treated alloy steels; high tensile strength aluminium is used for the pistons. The cylinders are made of special alloy cast iron, while the cylinder liners are of forged chrome-molybdenum steel and are removable. The liners have packings of heat- and oil-resisting rings, and the joint for the combustion space is made by a soft aluminium ring, with a composition gasket for the water connections to the cylinder jacket. The cylinders have a bore of 4·993in. with a stroke of 7in. There are two banks of six cylinders, placed at an angle of 45 deg. instead of the angle of 60 deg. employed in the larger engines. A feature of the design is the inspection covers, which give ready access to the water jackets. The induction system consists of two duplex Zenith carburettors, each carburettor barrel feeding three engine cylinders. A special system of cooling water control is provided, which includes a thermostat arranged in the outlet header so that a large proportion of the water in circulation is returned to the circuit at the inlet connection, only sufficient water being pumped overboard to maintain the engine at the operating temperature which may be desired. A circulating water pump of the gear pattern is used, which is furnished with a single inlet and a double outlet one to each bank of cylinders. The circulating water first passes through exhaust pipe jackets and then through the

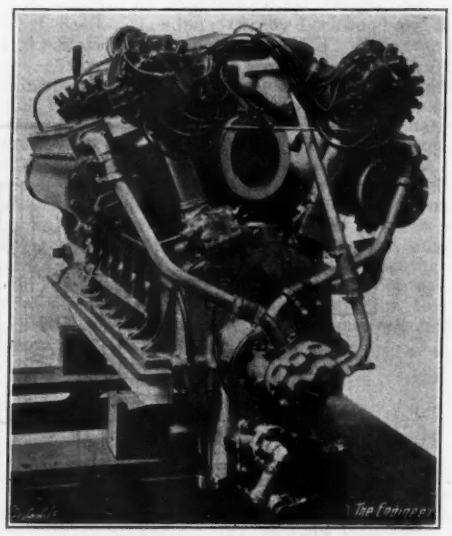


FIG. 191—"VIMALERT" ENGINE—WHITE

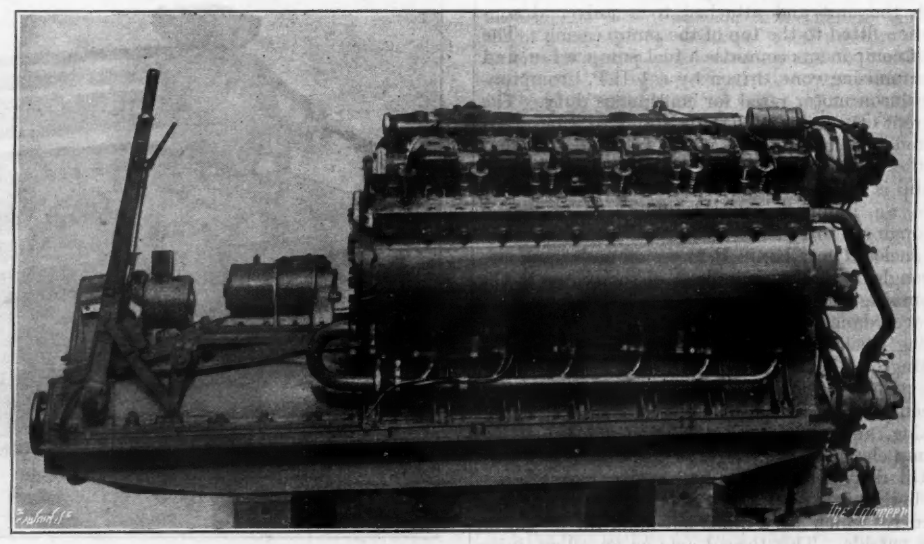


FIG. 190—400 H.P. "VIMALERT" MARINE ENGINE—WHITE

cylinder jackets to the inlet manifold jackets, and finally to the thermostatic control device. A connection to the lubricating oil cooler is also made, and the temperature control is such as to maintain the oil supply at a practically constant temperature. The engine is provided with a reverse gear of the planetary type, designed to give a reverse speed of 250 r.p.m. The nett weight of the engine we have described, complete with starting motor,

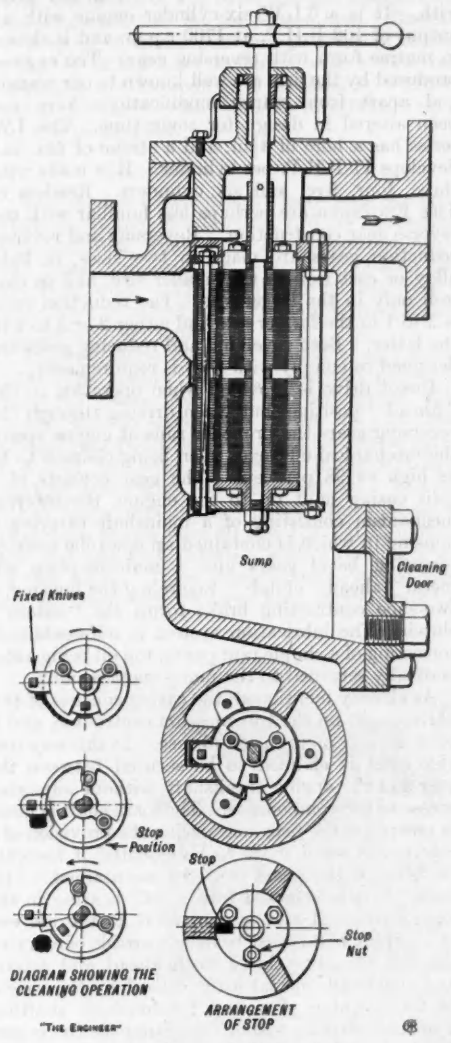


FIG. 191—OIL STRAINER—WHITE

generator, and other fittings, is about 2270 lb. for the engine when dry, and about 2360 lb. when in running order.

The White-Ford engine uses as its basis the Ford industrial V-8 engine which, as shown in Figs. 192 and 193, is of the eight-cylinder type, with the cylinders arranged in "V" formation. The cylinders have a bore of $3\frac{1}{16}$in. with a stroke of $3\frac{3}{4}$in., and the designed output is 65/68 B.H.P. at 2750 r.p.m. under continuous load rating, and a maximum load rating of 75 B.H.P. The corresponding consumptions of petrol fuel do not exceed 42/44 lb. per hour when operating at maximum power, while the consumption of lubricating oil is about $1\frac{3}{4}$ lb. per hour under continuous load conditions. The weight of the complete marine unit is light for its output, and is approximately 728 lb. The conversion of the engine has been carried out in a thorough manner in order to conform with marine practice. As will be seen from our engravings, the standard arrangement of belt drive for the dynamo and water pumps has been removed, and has been replaced by a geared drive which is better suited for marine service. Both the water pump and the dynamo are driven by helical spur gearing mounted on an extension to the forward end of the crankshaft, the dynamo running at full engine speed and the pump at half the speed of the engine. The gears are designed for noiseless operation and the shafts are supported in ball bearing journals, the whole of the drive being enclosed in an oil-tight, light alloy casing. The gearing is independently splash-lubricated. The water pump is of the gear type and has been specially designed for its duties. The outlet pipe from the pump is so arranged that water is circulated through an oil cooler, and then passes to the water-jacketted manifolds before it enters the cylinder cooling circuit. In place of the usual 6 volt equipment, usually supplied with a Ford engine, both the dynamo and the starter are designed for 12 volt operation.

For reversing, use is made of the familiar Parsons "F" type reverse gear, which is built in a casing of special aluminium alloy, bolted direct to the flywheel housing. In this particular gear the ahead drive is through a plate clutch with cone and lever operation, while astern motion is obtained by the means of a band brake. The lubrication of the gear is independent from that of the engine, and the gear can be adjusted without having to remove the gear-box cover. The exhaust manifolds are water cooled, and the design of the sump and the lubricating oil system has been modified in order to allow the engines to be installed in craft at angles up to 15 deg. Before despatch from the works each unit is run under test bench conditions so that the requirements of a high-speed marine engine with a good power-weight ratio are amply met and reliable running vouched for. Photographs of other products of the firm were also to have been shown on the stand.

British Gas Federation Industrial Exhibit

Many exhibits of industrial gas applications and equipment would have been shown on the British Gas Federation's stand, arranged by the British Commercial Gas Association, 1, Grosvenor Place, London, S.W.1. The stand would have been divided into a number of sections on which heat treatment equipment, burners, laboratory equipment, foundry equipment, and space heating plant representing the products of most of the firms manufacturing gas-fired plant would have been shown. We are unable in the space available to describe more than one or two of the exhibits.

Of widespread interest, particularly in view of the petrol rationing now in force, is a new design of automatic mixing valve which replaces the carburettor on petrol engines and enables town gas to be used instead. Apart from its obvious use in times of petrol shortage, the device is valuable on the test-bench.

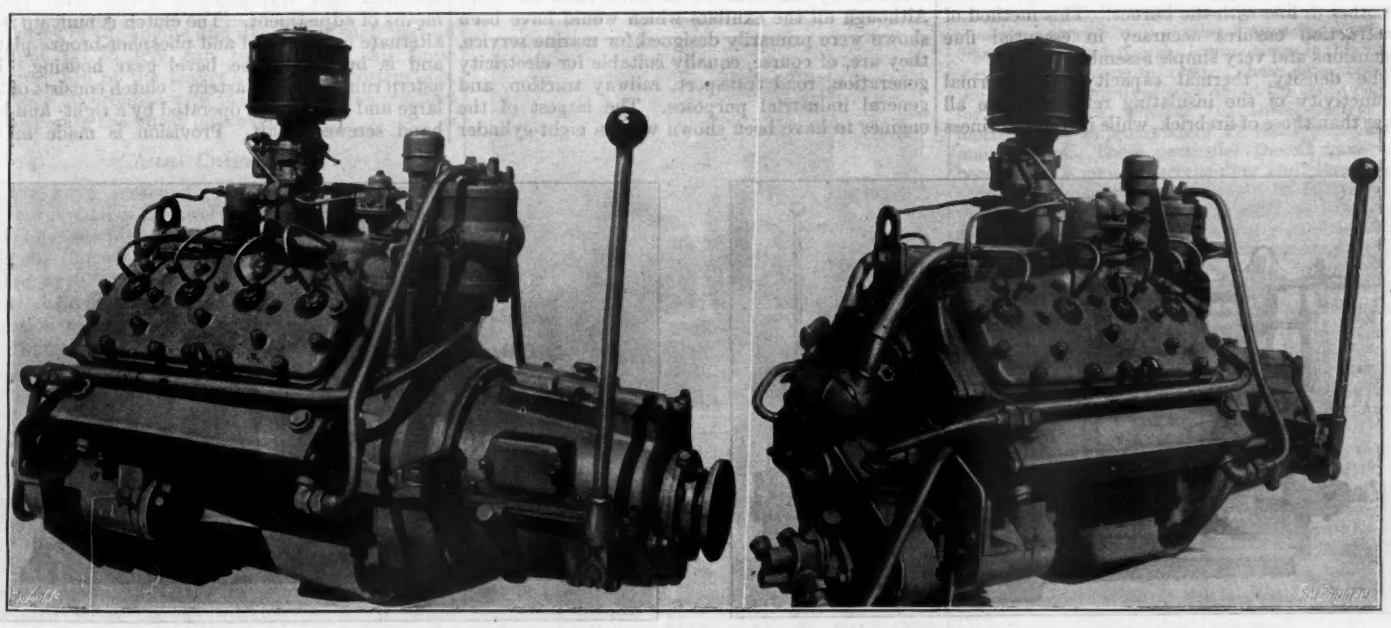
In Fig. 194 we illustrate a soft metal melting, pot fired by an immersion gas heater. The equipment is made by W. C. Holmes and Co., Ltd., of Huddersfield. It has a capacity of 5 tons and it is claimed that it has a working efficiency of more than 70 per cent. of the thermal input.

The use of immersion heaters for soft metal melting is claimed to offer considerable advantages over the method of external heating. The sensible heat from the combustion of the gas can be

FIG. 194—IMMERSION MELTING POT—BRITISH GAS

liberated in a space entirely surrounded by the metal to be melted so that no heat is wasted in heating settings and flues. Furthermore, the insulation round the pot is not in contact with hot gases so that it can be made much more effective. The immersion heater also has the advantage that the thermal capacity of the system is much lower than that of a brick-lined furnace and consequently closer control of temperature is possible.

In Fig. 195 is reproduced a diagram of an immersion heater using pre-mixed theoretical air-gas firing. The system is interesting, for considerable technical difficulties have had to be overcome before this type of firing could become a practical possibility. Briefly, air and gas in the required ratio—usually between 4 : 1 and 5 : 1 according to the flue gas analysis required and the gas quality—are sucked into a turbo-compressor



FIGS. 192 AND 193—75 B.H.P. WHITE-FORD MARINE PETROL ENGINE—WHITE

which thoroughly mixes and compresses them. The mixed gas is delivered at a pressure of about 1 lb. per square inch through a single pipe to the burner. The mixture is explosive and care must be taken to ensure that the linear velocity through any of the burner nozzles exceeds the flame velocity of about 3 ft./sec. Each burner is provided with a flame trap and fusible links connected to snap action valves are fitted in the pipe line to give immediate shut off in the event of a back fire. If these precautions are taken the system is claimed to be perfectly safe and lends itself particularly to immersion heating where the high back pressure existing in the heating units prevents the use of simple inspirators.

Referring to the diagram, it will be seen that the burner is situated at the bottom of the vertical tube and fires along the lower horizontal limb of the heater. The products of combustion are forced round the upper horizontal limb and up the vertical tubes to the exit, where the products are directed down on to the metal, reducing heat loss from the

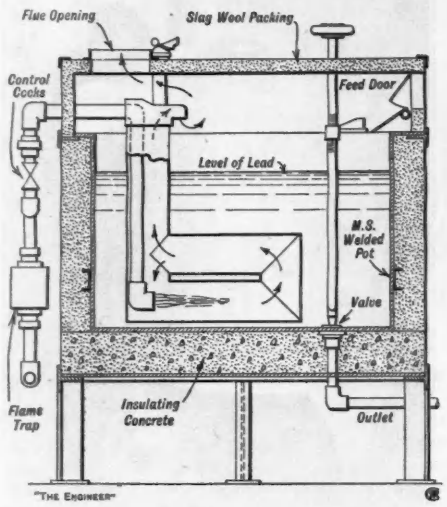


FIG. 195—IMMERSION HEATER—BRITISH GAS

surface and preventing the formation of dross. Automatic temperature control is provided.

We reproduce in Fig. 196 a photograph of a natural draught muffle furnace sectioned to shew the burner and flue systems. These furnaces are made by the Selas Gas and Engineering Co., Ltd., of Manchester, in six sizes with muffles ranging from 4in. by 2½in. by 2½in. to 14in. by 11⅝in. by 5¾in., in two types, one for temperatures up to 1000 deg. and the other up to 1250 deg. Cent. The photograph is of the first-named type, but the other is similar in appearance except that the outside dimensions are larger owing to the addition of extra insulation. Both types of furnace have polished cases to reduce heat losses from the surface to a minimum.

The design is interesting from a constructional point of view. The insulating refractory, specially developed for this type of work, is moulded in two sections splitting along the plane shown in the engraving. Locating grooves for the sections can be seen, one running just above the flue outlet and the other in line with the burner. This method of construction ensures accuracy in essential flue dimensions and very simple assembly.

The density, thermal capacity and thermal conductivity of the insulating refractory are all lower than those of firebrick, while its refractoriness is said to be excellent at 1300 deg. Cent. By its use in these furnaces it is possible to obtain a high rate of heat input with a relatively thin layer of insulation. The front and back aluminium castings, which also hold the casing in position, are bolted together by tie rods running longitudinally through the brickwork.

The combustion chamber in the high-temperature furnace is provided with pips, similar to a gas fire radiant. These projections become heated to incandescence by the passage of hot gases over them and provide a source of high radiant input

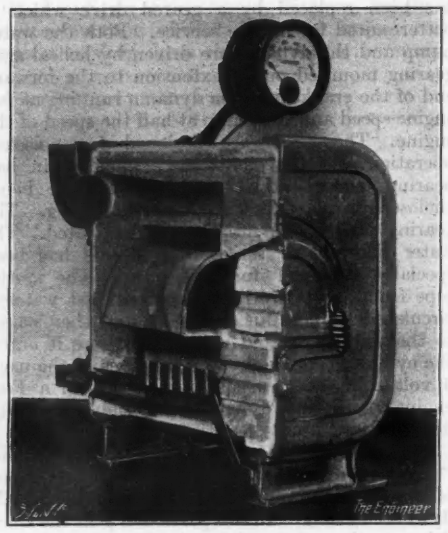


FIG. 196—MUFFLE FURNACE—BRITISH GAS

to the muffle. The muffles are made of fireclay, sillimanite, or silicon carbide and are easily replaced without dismantling the furnace.

In the low-temperature furnace the cast iron burner float is fitted with nozzles of heat resisting steel and fireclay and is cooled by the secondary air drawn round it from below. In the high-temperature type secondary air is drawn from the back of the furnace in order that the combustion chamber may be totally enclosed and radiation losses reduced to a minimum; for this reason a heat-resisting steel shield is provided to protect the burner float from the severe temperature conditions imposed on it. The primary air to the burners is injected by the gas stream and the aeration is controlled by a variable throttle on the injector.

The furnaces have a wide application both in the laboratory and in industry. It is possible to reach the maximum temperatures in from 1¼ to 2 hours, according to the size, and the design of the combustion chamber ensures uniformity of temperature inside the muffle.

Norris, Henty, and Gardners, Ltd.

On the stand which was to have been taken at the Exhibition by Norris, Henty, and Gardners, Ltd., of Barton Hall Engine Works, Patricroft, Manchester, oil engines representing the range manufactured by the firm would have been on view. Although all the exhibits which would have been shown were primarily designed for marine service, they are, of course, equally suitable for electricity generation, road transport, railway traction, and general industrial purposes. The largest of the engines to have been shown was an eight-cylinder 8L3 unit designed to develop 136 B.H.P. at 800 r.p.m., provided with compressed air starting gear and the firm's unit construction reversing and reduction gear. A similar four-cylinder engine would have been on view fitted with a unit construction direct drive reversing gear, also 6L2 and 4L2 engines, developing 60 B.H.P. and 40 B.H.P. respectively at 1000 r.p.m., showing the application of each type of reversing gear.

Another exhibit is illustrated in Fig. 197 herewith. It is a 6 L W six-cylinder engine with an output of 102 B.H.P. at 1700 r.p.m. and is shown in marine form with reversing gear. The engines produced by the firm are well known to our readers and apart from minor modifications have not been altered in design for some time. The LW series has a bore of 4¼in. and a stroke of 6in. and develops 17 B.H.P. per cylinder. It is made with three, four, five, and six cylinders. Readers of The Engineer are perhaps less familiar with the reverse gear construction. Reversing and reverse-reduction gears are made in two sizes, in light alloy or cast iron in the smaller size, and in cast iron only in the larger size. The reduction ratio is 2 to 1 in the former size and either 2 or 3 to 1 in the latter. Both reversing and reducing gears are designed to comply with Lloyds requirements.

Direct drive is provided when operating in the "ahead" position, but when driving through the reversing gears the propeller runs at engine speed, the mechanical efficiency then being claimed to be as high as 98 per cent. The gear consists of a split casing built on to the engine, the internal mechanism consisting of a mainshaft carrying a housing in which is contained an epicyclic train of reversing bevel gears and a multiple-plate all-metal "ahead" clutch. Encircling the housing, a two-shoe contracting brake forms the "astern" clutch. The lubrication system is self-contained, consisting of a simple ram pump, the oil being automatically returned to the pump suction sump.

As already mentioned, the casing consists of two halves, split on the transmission centre-line, and is built directly on to the crankcase. In this way true alignment is claimed to be secured between the gear and the engine crankshaft, without impairing access to the components. The main shaft is made in one piece, the firm considering the provision of a continuous main shaft to be essential if accurate meshing of the gears is to be maintained. This main shaft is spigoted into a ball bearing in the engine flywheel and is supported at the aft end in a duplex ball-thrust bearing, capable of carrying the full propeller thrust both ahead and astern, and the small journal loads caused by the weight of the running gear and intermediate shafting. The main-driving spider is centred on the engine flywheel and carries the major portion of the weight of the reversing gear housing, but is designed to permit longitudinal movement, providing for the free thermal expansion of the running gear and casing. Thus, thrust loads on the bearings and gears are eliminated.

The driving and driven bevel gears and four planet pinions are carried in a rigid housing on ball and roller bearings, it being claimed that the mesh of the gearing cannot be disturbed by internal or external forces. In "ahead" operation, the "ahead" clutch is operated by four counter-balanced and spring-loaded levers with simple means of adjustment. The clutch is built up from alternate carbon steel and phosphor-bronze plates, and is built into the bevel gear housing. For astern running, the "astern" clutch consists of two large and rigid shoes, operated by a right- and left-hand screwed shaft. Provision is made in the

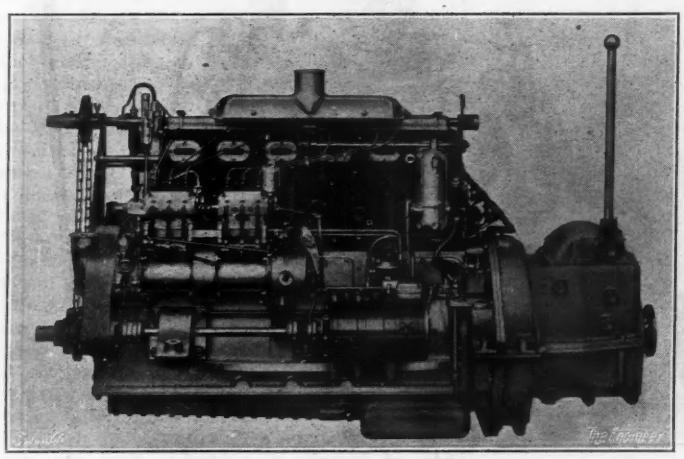


FIG. 197—102 H.P. MARINE OIL ENGINE—NORRIS

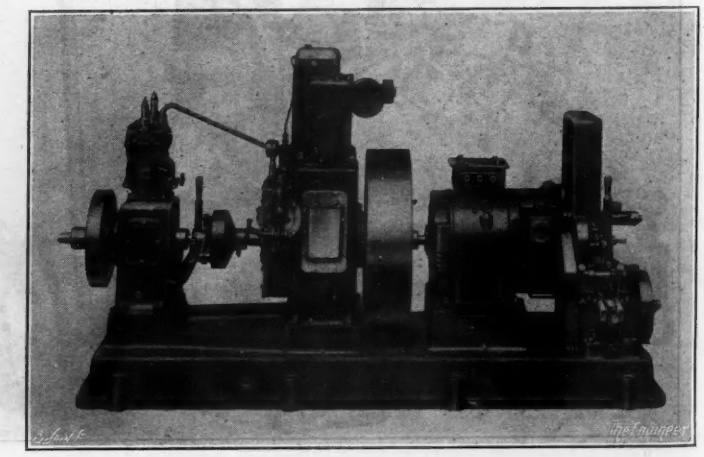


FIG. 198—9½ H.P. SHIP'S AUXILIARY SET—NORRIS

pivot mounting to give a definite running clearance between the bevel gear housing and the clutch shoes when operating in the "ahead" or neutral positions.

Another exhibit would have been the small ship's auxiliary set illustrated in Fig. 198. The set is driven by a 9½ B.H.P. 1L2 Gardner engine, and comprises a 5 kW generator, an air compressor, and a general service pump. The compressor is of the firm's manufacture and is of the two-stage pattern, with a capacity of 11½ cubic feet per minute of air compressed to 360 lb. per square inch. Running at a speed of 1000 r.p.m. the L2 series of engines gives 9½ B.H.P. per cylinder with a fuel consumption not exceeding, it is claimed, 0·370 lb. per B.H.P. hour. Any number of cylinders up to six can be supplied.

Gleniffer Engines, Ltd.

The engines which were to have been shown at Olympia by Gleniffer Engines, Ltd., of Anniesland, Glasgow, W.3, would have been representative of the latest products for marine propulsion and auxiliary work. Altogether four models were to have been exhibited, three for ship propulsion and one for auxiliary lighting.

The propelling engines included a six-cylinder DB6 type engine, having a designed output of 72 S.H.P. when running at 1000 r.p.m. This engine was to have been shown complete with reverse gear and a two-to-one double-helical reduction gear, while the Gleniffer air motor system of starting would have been demonstrated. The two other main propulsion engines which were to have been shown were 80 and 120 S.H.P. units of the DC4 and DC6 patterns, with a running speed of 900 r.p.m. These engines have reverse gear, and all units were to have been demonstrated as working exhibits. The generating set which we illustrate in Fig. 199 consists of a twin-cylinder Gleniffer oil engine, having a rated output of 24 B.H.P. when running at 1000 r.p.m., coupled direct to a Sunderland Forge generator with a designed output of 10 kW. In actual service the capacity of the engine and dynamo is such that an output of 15 kW can be reached. All these engines are of the maker's standard construction, built in accordance with marine requirements, and incorporate the latest improvements.

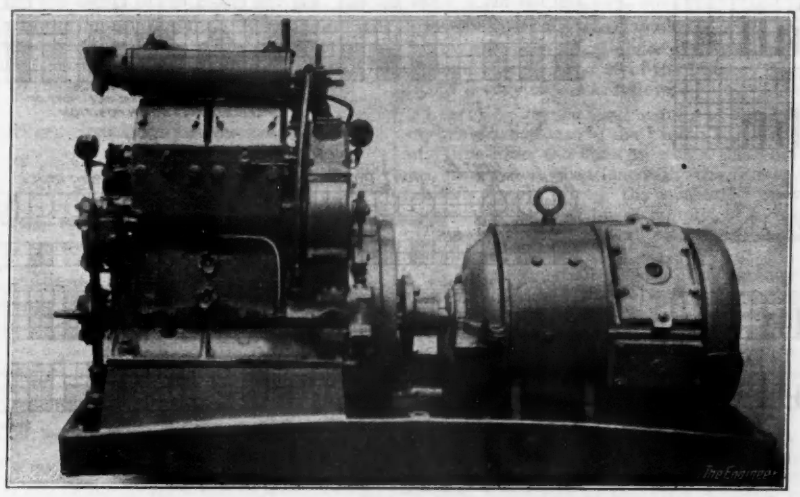


FIG. 199—MARINE GENERATING SET—GLENIFFER

Ailsa Craig, Ltd.

We have chosen for illustration in Fig. 200 a new version of the twelve-cylinder marine V-type engine made by Ailsa Craig, Ltd., of Strand-on-the-Green, Chiswick, London, W.4. Previously the Acro type of combustion chamber was used in this engine, but the makers now fit Ricardo combustion chambers and, with other modifications, its output has been increased from 96 B.H.P. to 120 B.H.P. at 1000 r.p.m., and from 144 B.H.P. to 180 B.H.P. at 1700 r.p.m. Similar engines, but not of the V-type, are made with from one to eight cylinders. The design of the engine illustrated follows in general that of its forerunner. The twelve cylinders are arranged in two banks of six cylinders each, inclined at an angle of 70 deg. The bores and strokes are 4⅛in. and 5½in. respectively. The crankcase is a monobloc casting, carried up to the cylinder heads in one piece box section framing. Large doors are fitted in order to give access to the working parts. A single camshaft mounted in the crankcase between the cylinder blocks operates overhead valve mechanism through push rods. Both camshaft and crankshaft run in seven bearings, and each connecting rod is separate from its corresponding one in the other bank of cylinders, the big ends working upon a common crankpin.

C.A.V.-Bosch fuel pumps in two units of six are mounted between the cylinders and driven in tandem from gearing at the front of the engine. A centrifugal fuel pump governor is mounted on the top of the timing gear casing. Force feed lubrication is effected by means of a gear type pump, the oil circulating from the sump through filters and an oil cooler. Air cleaners are provided on each of the six air intakes. Cooling water circulation is effected by a rotary gun-metal pump. These engines can be fitted with a reverse gear, or a reverse and reduction gear, for marine use, employing helical wheels fully enclosed with a thrust block in one unit with the engine. The engine illustrated in Fig. 200 is fitted with the reverse gear only.

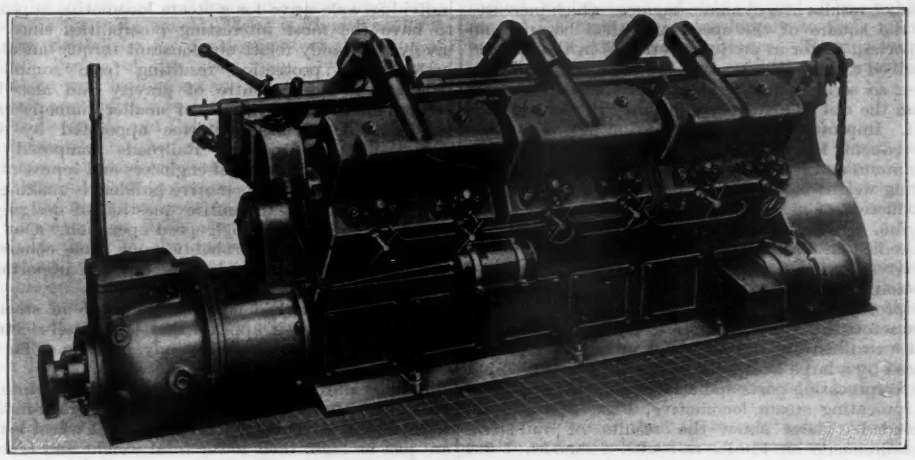


FIG. 200—TWELVE-CYLINDER MARINE OIL ENGINE—AILSA CRAIG

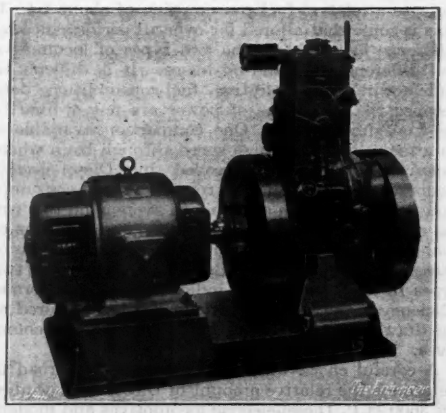


FIG. 201—GENERATING SET—AILSA CRAIG

Another exhibit which would have been shown is the generating set illustrated in Fig. 201. This set is designed for an output of 5 kW alternating current, and the alternator is driven by an Ailsa Craig single-cylinder oil engine, developing 8 B.H.P. at 1000 r.p.m. The engine is provided with two flywheels and is claimed to produce a steady torque making it very suitable for current generation, for industrial or marine auxiliary service. In general, the engine follows the firm's standard practice. It has a bore of 4⅛in. and a stroke of 5½in.

High-Speed Lightweight Trains *

By C. T. RIPLEY †

(*Continued from page 456*)

Relative Cost of Maintenance of Diesel-Electric and Steam Locomotives

There is a great deal of controversy as to the relative cost of maintenance of Diesel-electric locomotives and steam locomotives. It is difficult to secure reliable data from which to make comparisons. The comparison of costs on different railroads is open to question because of difference in operating conditions and accounting practices. The two types of power are not regularly used in the same type of service on the same railroad. Furthermore, the Diesel-electric locomotives are rather new and very few of them have received general repairs. It may be said that the two types are definitely different in regard to general repairs; the steam locomotive because of its boiler, flues, and firebox must be given general overhauling at relatively frequent periods. The Diesel-electric locomotive, on the other hand, is being constantly repaired by the regular replacement of the wearing parts. Some roads have put them in the back shop for general repairs after about 750,000 miles of service. It was originally thought that this might be the life of the major element of the Diesel motor, the crankshaft, but it has developed that the life of this part will normally be greatly in excess of this figure, and some roads are planning on one million or more miles between general shoppings.

The best available data appear to be the five-year-period maintenance-expense figures of a group of Pacific-type locomotives with approximately 3800 maximum I.H.P. capacity, operating in normal passenger service, and similar figures for a group of 3600-H.P. Diesel-electric locomotives in high-speed service on the same railroad. These data show that the steam locomotives cost about 20 cents per mile for maintenance, whereas the Diesel-electric locomotives cost approximately 17 cents per mile for maintenance. These particular Diesels have never been given a general overhauling and, therefore, in order to be conservative, it might be fair to add as much as 3 cents per mile to this figure. These data indicate that it may be conservatively claimed that Diesel-electric locomotives can be maintained for at least the same cost as steam locomotives. If this same group of steam locomotives were operated at high speed, the repair costs would undoubtedly be greater than the 20 cents shown. It is claimed by the builders of steam locomotives that the most modern type will have a lower cost of maintenance than older types, but it can also be claimed that the details of Diesel-electric locomotives are being steadily improved with a resultant reduction in maintenance cost. It must be recognised that costs on different railroads vary widely, particularly those applying to Diesels, since they are new and maintenance forces are not as familiar with them as they are with the steam locomotive. Furthermore, most railroads' repair facilities were designed for steam-locomotive work and are not

* *The American Society of Mechanical Engineers*, Sept. 4–8, 1939.

† Chairman, A.S.M.E. Railroad Division.

suitable for efficient handling of Diesel repair work. New facilities are gradually being provided for taking care of Diesel work and their use should result in some reduction in maintenance cost.

Track Stresses

Every steam locomotive must have a certain amount of over-balance in the driving wheels, in order to balance the reciprocating parts. This over-balance results in a dynamic augment which increases as the square of the speed and thus becomes an important factor in producing stresses in the rail and roadbed at high speed. In some cases this effect has been so serious that the main drivers actually lift from the rail at high speed and may produce kinked rail. Improvement in this condition has been made by reducing the weight of the reciprocating parts to a minimum and reducing the percentage of the reciprocating weight balanced to a minimum limited by the production of nosing and fore-and-aft motion of the engine. A still further effort along this line is embodied in the new experimental designs of locomotives having two complete sets of cylinders and motion work. This not only reduces the weight of reciprocating parts but gives another desirable characteristic, that of more constant torque. In order to illustrate the difference in rail stresses produced by a large Diesel-electric locomotive which has no reciprocating parts and a large modern high-speed reciprocating steam locomotive, Figs. 2 and 3 are included. These show the results of rail-stress measurements on 110-lb. rail with a modern 4–6–4 type locomotive and a 3600-H.P. Diesel-electric locomotive. Fig. 2 shows stresses on a 5-deg. curve at speeds of 5 and 45 m.p.h. and Fig. 3 stresses on level tangent track at speeds of 5, 60, and 100 m.p.h. In Fig. 2 the stresses are shown separately for both edges of both rails, and the maximum stress at each location, as represented by the average of three highest readings at each location, is shown in short horizontal lines. In Fig. 3 the average vertical stress in the rail base is shown and the effect of the counterbalance by indicating its relative position. The maximum stress is also an average of three maximum values. The damaging effect of counterbalance is clearly shown in these data which are actual stress measurements and not calculations.

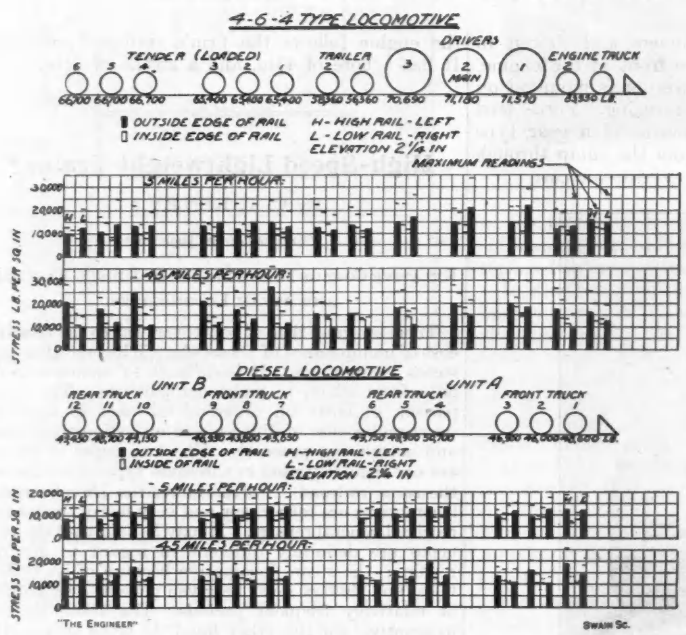
If a steam locomotive slips at high speed, the rotational speed of the driving wheels may be greatly in excess of that involved in these tests, therefore, the dynamic augment and resulting rail stress are greatly increased. The high rail stresses under steam-locomotive tenders due to too-high loads on small-diameter wheels may also be noted. Large tenders are necessary on high-speed locomotives in order to reduce to a minimum the delays for taking fuel and water, but it appears necessary to add two more pairs of wheels or increase the diameter of the wheels, in order to reduce wheel loads to a reasonable figure where damage to both track and wheels is not excessive.

No complete data are available for rail stresses under 4–8–4 type high-speed steam locomotives. However, the tests made indicate that rail stresses under the main drivers of such locomotives are about 25 per cent. greater than those shown for the 4–6–4 type. This is due to the fact that the reciprocating parts in these larger and higher-powered engines are heavier and the driving-wheel diameter is usually made smaller to meet heavy-grade operating conditions.

All of these track-stress data point to the need of a radical change in steam-locomotive design for competition with the Diesel-electric locomotive in high-speed passenger-train operation. The four-cylinder design is a step in the right direction. The individual-axle drive proposed by the Baltimore and Ohio Railroad is a further step and also the new turbo-electric type. Up to the present time the gear-drive turbine locomotive has not been tried out in this country, but it too may have possibilities. The individual-axle drive for a steam locomotive appears to have the most interesting possibilities since it involves not only relatively constant torque but also better track protection resulting from complete balance. A lower centre of gravity can also be secured since driving wheels of smaller diameter can be used. A special committee appointed by the Association of American Railroads composed of leading railway mechanical engineers and representative engineers of the locomotive builders is making a thorough study of the entire question of design of steam locomotives for high-speed operation. Out of their work there will probably come some concrete and valuable recommendations on this important question.

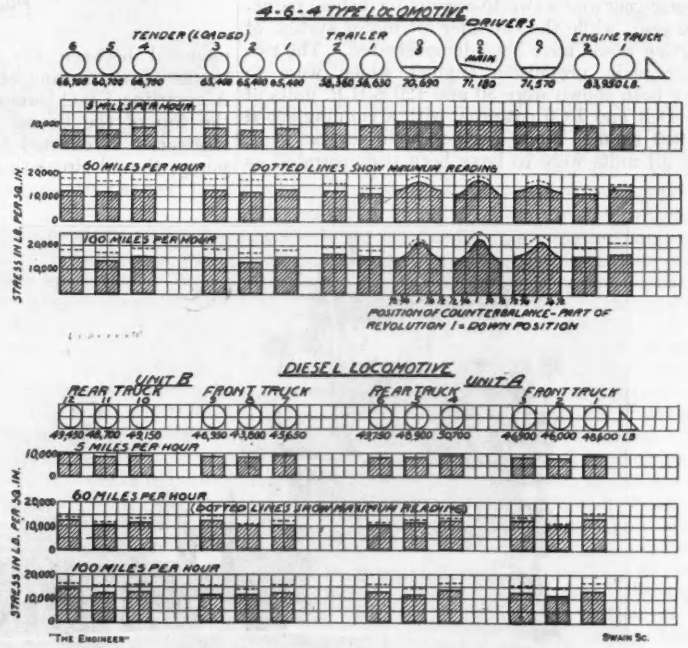
Until some marked changes are made in steam-locomotive design it appears that the Diesel-electric locomotive will have a definite advantage in so far as effects on rail and roadbed are concerned.

Lightweight passenger cars also have an advantage over conventional cars in the matter of track-maintenance costs. Though their individual wheel loads are just as high, their lower total weight and trucks with shorter wheel base result in lower lateral rail pressures in high-speed operation.



(Five-deg. curve, 110-lb. rail)

Fig. 2—*Mean Stresses in Rail Base under each Wheel*



(Tangent track, 110-lb. rail)

Fig. 3—*Vertical Stresses in Bases of both Rails*

Thermal Efficiencies

The theoretical maximum thermal efficiency of the Diesel-electric locomotive figured on the basis of energy developed at the rail is about 27 per cent., whereas the corresponding figure for a modern steam locomotive seldom exceeds 7 per cent., which would indicate a relative fuel consumption of about 1 to 4. This is somewhat altered for over-all performance by difference in weight of the two types of locomotive and difference in stand-by losses. It is difficult to find accurate comparative fuel-consumption data because the two types of power are not ordinarily used on similar runs. One comparison available is on a main-line fairly high-speed through train where steam power was superseded by Diesel-electric locomotives. The relative round-trip fuel-consumption figures based on a 12-month average on this run are as follows: Steam locomotives used 124 tons of coal; Diesel-electric locomotives used 3950 gallons of Diesel oil. Based on the B.T.U. content of the two types of fuel, these data indicate that the thermal efficiency of the Diesel-electric locomotives figured at the drawbar was 5·5 times that of the steam locomotives.

A careful check was made on another railroad to determine the relative amount of Diesel oil consumed by 3600 H.P. Diesel-electric locomotives and modern Pacific-type oil-burning steam locomotives, when pulling both light and heavy medium-speed main-line passenger trains on a 550-mile run. These data show the steam-locomotive oil consumption to be approximately four and one-half times that of the Diesel-electric locomotives.

There appears to be little chance of improving the efficiency of the Diesel-electric locomotive except in the factor of transmission loss. There should be a possibility of marked improvement in steam-engine efficiency because of the many losses now involved. There has been a steady improvement in steam-locomotive thermal efficiency as indicated by the figures of the Association of American Railroads, which show that in 1920 it took 173 lb. of coal to produce 1000 gross-ton miles of freight transportation and 18·8 lb. of coal per passenger-car mile, whereas in 1938 these figures were only 113 lb. for freight and 14·7 lb. for passenger trains. A large part of this fine showing is undoubtedly due to improvements in steam-locomotive design and the reductions would be even greater if all the locomotives in service were of a modern type. Credit is due to the designers for these improvements, which incidentally have been developed without the urge of competition from other types of power. Naturally under noncompetitive conditions the designers have been more or less bound by precedent. Conditions have now been changed. The young virile Diesel locomotive (whose designers were not swayed by precedent and who had at their disposal the vast amount of research data developed by the automotive industry) has reached a remarkable state of development in the short period of five years. This new competition should prove to be a spur and a benefit to the steam-locomotive designers, as is indicated by the numerous new designs which are mentioned elsewhere in this paper.

The Diesel designers had an advantage in connection with high-speed operation in that they started their development of road locomotives on the basis of high speed (top speed 118 m.p.h.). On the other hand, steam-locomotive designers focused their attention on the improvement of thermal efficiency and greater power development with top speeds of about 90 m.p.h. Thus when the demand for high-speed operation developed so rapidly, their designs were not entirely adequate. This feature of high speed is the one which is now being given major consideration, and improvement should result.

Electric Locomotives

The modern electric locomotive is also a highly satisfactory type of motive power for high-speed operation, both from the viewpoint of capacity and effect on track structure. Early types had detrimental effects on track due to high lateral forces, but later designs have overcome this. The use of this type of power in this country has been limited, due to the fact that the density of traffic on most railroads does not warrant the high cost of overhead construction. Where it is used for long-distance high-speed operation, as on the Pennsylvania Railroad, between New York and Washington and Harrisburg, it has shown excellent performance, but there appears to be little probability of electrification of less dense traffic lines, particularly those in the western part of the United States.

Operating Expenses

In 1938 Coverdale and Colpitts issued a comprehensive report covering the results of their studies of operating costs and revenues of a majority of the streamlined trains in operation at that time. The cost data for the various railroads show such wide variations that it is difficult to arrive at a fair average figure for cost of operation of Diesel locomotives as compared with steam. Unfortunately, there are no roads on which comparable trains are operated with steam and Diesel-electric locomotives, so that there is no fair basis for comparison. However, a study of all the data in this report indicates that the cost of maintenance of a 3600-H.P. Diesel-electric locomotive

is no greater and probably less than that of a modern steam locomotive of similar power, handling equal-weight trains on fairly comparable schedules. The fuel cost is approximately one-half as much. The cost of crew wages is about the same, though it should be noted that on some roads a maintainer is included in the crew of Diesels for long-distance operation. This should not be necessary when firemen are fully trained in their work on this type of power. Lubrication costs (a lesser factor) are greater for Diesels than for steam locomotives. It is noticeable that the maintenance costs for Diesels are higher when the total load is much above 450 lb. per H.P.

The outstanding feature of this report is the large margin between gross revenue and net revenue (depreciation charges are not included). Most of the trains show net revenue over 50 per cent. of gross revenue and in some cases this is as high as 75 per cent. These figures, are, of course, unduly favourable because of the omission of two important factors, namely, the overhead charges for depreciation and interest, and the item of track maintenance. The overhead in one particular case is shown in Table VI of this paper. Even with the high mileage made by such trains, the overhead is a major item of expense because the first cost of these trains is high. As to track maintenance, it is well recognised that safe and comfortable high-speed operation necessitates a high standard of track maintenance. Furthermore, high-speed operation, particularly with steam locomotives, increases the cost of maintenance, though no definite figures are available to determine such extra cost. It is a fact that large expenditures have been made, particularly on the western railroads, to eliminate curvature and alter curves to make high-speed operation successful. As an example of this, it may be noted that one transcontinental railroad spent over four million dollars on such work during the last three years, and similar work is still under way. The total cost of these improvements should not be charged against the operation of the new trains, for these changes also benefit the operation of other trains. Nevertheless, it must be admitted that there is a considerable part of this extra expense which should properly be charged against the new trains to give a full picture of the financial results. If speeds are still further increased, this factor will become of even greater importance as more work of this kind will be necessary to make such schedules.

Coach-Type Streamliners on Long Runs

Table VI shows a comparison of weights and operating costs between two streamlined trains operating in similar transcontinental service on one railroad. One of these trains is a first-class all-sleeping-car train and the other is an all-coach train.

Table VI.—*Comparison of Operating Costs for a First-class All-sleeping-car Streamliner and an All-coach Streamliner*

Item.	First-class train.	All-coach train.	Estimated 10-car all-coach train.
Number of cars	9	5	10
Number of Diesel power units	2	1	2
Horsepower of locomotive	3600	1800	3600
Total weight of cars, tons	482	248	496
Weight of power units, tons	287	147	287
Total weight of train, tons	769	395	783
Length of train, ft.	890	473	970
Total saleable seats or berths	121	156	312
Out-of-pocket cost per mile of operation *	$0.88	$0.68	0$.88
Train length per passenger (full load), ft.	7·4	3·0	3·0
Car weight per passenger, tons	4·0	1·6	1·6
Train weight per passenger, tons	6·4	2·5	2·5
Out-of-pocket cost per passenger per mile of operation	$0.0073	$0.0043	$0.0028
Total yearly operation, miles	232,000	232,000	232,000
Total first cost of train	$1,110,000	$580,000	$1,160,000
Overhead cost per mile, based on 10 per cent. of first cost	$0.48	$0.25	$0.50
Overhead cost per passenger per mile (full load)	$0.004	$0.0016	$0.0016
Overhead and operating cost per passenger mile (full load)	$0.0113	$0.0059	$0.0047

* This cost does not include sleeping-car employees' wages or maintenance expense for sleeping cars.

All of the data are prepared on the basis of full load of passengers which, of course, is not always the case. Estimated data are also shown for a train similar to the coach streamliner but with twice the capacity. All operating costs are taken from the Coverdale and Colpitts report.

It may be noted that the train weight per passenger for the first-class train is 6·4 tons, whereas for the coach train it is only 2·5 tons, which accounts largely for the higher out-of-pocket cost for the former. The overhead cost per passenger is more than twice as great. The total overhead and operating cost per passenger mile is approximately twice as great for the first-class train as for the coach train. It is thus apparent that much lower rates can be charged on coach trains. This latter type of train has been remarkably successful in attracting passengers for this long run, although it involves their spending two nights on the road.

It is the coach type of train that primarily has the possibility of diverting traffic from private automobiles and buses to the railroads. Because of the low rates it also has the possibility of developing a large amount of new traffic among people in the low- and medium-income group, who are becoming more and more travel-minded and have more and more time available for such travel. There is almost no limit to the possibilities for development of this type of travel. People of this class want low-cost transportation with high speed and comfort. All of these are being provided in such trains.

The Coverdale and Colpitts report shows remarkably successful results from the operation of all of the high-speed streamlined trains. They have undoubtedly brought back to the railroads some of the lost traffic and give promise of developing new traffic.

It appears that these new high-speed trains, particularly those in the western territory are now operating at about the maximum speed, which is possible on the present track structure. The limitation to further increase in speed lies in the large number of rather sharp curves which are unsafe for too high speed and uncomfortable for passengers when taken too fast. The number of unprotected grade crossings is also a limitation, as well as speed restrictions through towns with grade crossings. It would be very expensive to correct all of these track conditions.

Outside of the passenger-traffic gain, these new trains have been warranted by the public interest which they have aroused. Prior to their advent, there was a feeling that the railroads had not kept pace with developments as they should have, and consequently the public had less interest in their welfare. They are now much more favourably inclined and this may have an influence on future legislation.

Large numbers of new lightweight cars are now being added to main-line trains, and there is a gradual replacement of old types. The public demand for such cars is due largely to their many comforts and attractive appearance. There is every indication that there is a real revolution in American passenger trains.

Conclusions

The streamlined high-speed passenger train has been definitely successful on American railroads in recovery of traffic, financial return, and mechanical performance. The number of such trains in service should continue to increase.

Both steam and Diesel-electric locomotives will pull these new trains, but the Diesels will predominate unless new designs of steam locomotives prove themselves better suited for the long high-speed runs than are the present types. There should be a continual improvement in the design details of Diesel-electric locomotives. Radically new designs of steam locomotives will probably be built to meet the high-speed operating conditions.

Schedules faster than those now being made are possible and probable as soon as roadway conditions are further improved by curvature reduction and grade-crossing elimination.

Iron and Steel Products Control

Whereas it appears to the Minister of Supply to be necessary for maintaining supplies and services essential to the life of the community and expedient that this Order should be made :—

Now therefore the Minister of Supply in pursuance of Regulations 55 and 98 of the Defence Regulations, 1939,* hereby orders as follows :—

1.—(1) No person shall acquire or agree to acquire any material situate in the United Kingdom on or at any time after the date on which this Order comes into force and mentioned in the First Schedule hereto : except under the authority of a licence granted by the Minister of Supply, or in accordance with a special or general direction issued by the Minister of Supply.

(2) No person shall dispose of or agree to dispose of any material situate in the United Kingdom on or at any time after the date on which this Order comes into force and mentioned in the First Schedule hereto : except to a person who is authorised to acquire that material by virtue of a licence granted by the Minister of Supply, or by virtue of a special or general direction issued by the Minister of Supply.

(3) Nothing in this Article shall be taken to prohibit or restrict the delivery to and acceptance by a person carrying on the business of a carrier of any material mentioned in the First Schedule hereto in the ordinary course of that business, or the delivery by and acceptance from such a person of any such material in the ordinary course of that business.

2.—(1) No person shall buy or sell or agree or invite an offer to buy or sell for delivery in the United Kingdom any material situate in the United Kingdom on or at any time after the date on which this Order comes into force : except at a price which is either

(*a*) not in excess of the maximum price for material of that description in force under this Order at the time of such purchase or sale or agreement or offer or invitation of an offer to buy or sell ; or

(*b*) defined in such a way that it cannot exceed such maximum price for material of that description as may be in force under this Order at the time of delivery of such material.

(2) (*a*) For the purposes of this Article, the maximum price for material of any description in force under this Order at any time shall be ascertained from the Second Schedule hereto and the Related Schedules.

(*b*) The Second Schedule hereto and the Related Schedules may be varied, and further Related Schedules may be added to this Order, by special or general direction issued by the Minister of Supply.

(3) In the case of any material mentioned in the First Schedule hereto being material of a description for which no maximum price is in force under this Order, any person shall comply with any notice given (or special or general direction issued) by the Minister of Supply

(*a*) requiring that person not to sell or agree or offer to sell for delivery in the United Kingdom any such material at a price exceeding a maximum price to be fixed by the Minister of Supply for that material, or

(*b*) fixing the maximum price for that material.

3.—For the purposes of Articles 1 and 2 of this Order, material which is or is agreed to be acquired bought disposed of or sold, or which is the subject of an offer or invitation of an offer to buy or sell, shall be deemed to be situate in the United Kingdom on or at some time after the date on which this Order comes into force : unless it is proved that at the time at which it was or was agreed to be acquired bought disposed of or sold, or became the subject of an offer or invitation of an offer to buy or sell, it was situate outside the United Kingdom or was non-existent and was to come into existence outside the United Kingdom.

4.—Every person whose business or part of whose business it is to merchant, produce or consume any material mentioned in the First Schedule hereto shall upon being requested so to do by the Minister of Supply, furnish to the Minister of Supply within such time and in such form as he may direct, such returns and other information relating to that material and to the business of that person as the Minister of Supply may require.

5.—Every person owning or having power to dispose of or being in possession or control of any material mentioned in the First Schedule hereto shall, upon being requested so to do by the Minister of Supply, furnish to the Minister of Supply within such time and in such form as he may direct, such returns and other information relating to that material and to the business (if any) of that person as the Minister of Supply may require.

6.—(1) The holder of any licence granted under this Order shall comply with any conditions contained in the licence.

(2) If any licence granted under this Order is revoked by the Minister of Supply the holder of the licence shall forthwith deliver up the licence as directed by the Minister of Supply.

7.—(1) In this Order, the expression "Related Schedule" means any one of the related price schedules for iron and steel products lodged with the Minister of Supply for the purposes of this Order and certified as a "Control of Iron and Steel (No. 4) Order, 1939 : Related Schedule No.....", by the signature (dated with the date of certifying) of the Minister of Supply : the number of which Related Schedules at the coming into force of this Order is seventy-three.

(2) In this Order the expressions "acquire" and "dispose of" include respectively the taking and giving of possession.

8.—(1) The Control of Iron and Steel (No. 2) Order, 1939,* shall cease to have effect as from the coming into force of this Order.

(2) This Order shall come into force on the 1st day of November, 1939, and may be cited as the Control of Iron and Steel (No. 4) Order, 1939.

Dated this 31st day of October, 1939.

E. LESLIE BURGIN,
Minister of Supply.

FIRST SCHEDULE

1. Ore (excluding Iron Pyrites and Cupreous Pyrites, but including Pyrites ash and burnt pyrites residues whether in briquetted or other form) containing not less than 15 per cent. of iron.

2. Manganese Ore ; Ore, concentrate or residue containing Tungsten, Molybdenum or Vanadium.

* S.R. and O., 1939, No. 927.

* S.R. and O., 1939, No. 1272.

3. Ferro-Alloy of any kind, Molybdenum Metal, Calcium Molybdate, Molyte, bricks and briquetted forms of Molybdenum Dioxide and of Molybdenum Trioxide, Tungsten Metal, Tungsten Carbide, Cemented Carbide Hard Metal, Calcium Silicide.

4. Cinder and Scale produced during the manufacture or mechanical treatment of Iron and Steel.

5. Iron and Steel in any of the following forms :—

Pig ; Ingot ; Billet, bloom slab ; Tinplate bar, sheet bar ; Plate, medium plate, sheet (and whether coated or uncoated) ; Angle, channel, tee, joist, piling section, other sectional material (and whether fabricated or not) ; Round, rod, square, hexagon, flat, other section and shape (and whether black or bright) ; Rail, sleeper, fishplate, soleplate ; Tinplate, terne plate, black plate, silver-finished plate ; Hoop, strip (and whether coated or uncoated, and whether hot or cold rolled) ; Tube, pipe, and standard fittings therefor (and however made) ; Tyre, axle, wheel ; Casting, block for forging, block for pressing, forging, stamping, pressing ; Colliery Arch, and accessories therefor, pit prop ; Bolt, nut, washer, rivet, screw, spike ; Railway spring (and whether laminated or coiled) ; Bridge, pier, tank, plate and other structural steel work, in assembled or partly assembled form (and whether complete or incomplete) ; Wire Rod ; or Coated or uncoated wire whether plain or barbed, wire rope, wire strand, wire netting, wire chain link fencing, wire mesh, wire nail, wire staple.

SECOND SCHEDULE

Maximum United Kingdom Prices for Iron and Steel Products

Unless otherwise stated, prices set out or referred to in this Schedule, are basis prices per ton, for the quantity (if any) shewn, delivered to buyer. Other prices (related or additional) for products of the classes set out below, and extras allowances and rebates, shall be those provided for in or calculated in accordance with the Related Schedules.

Iron Ore—

All prices are f.o.t. at quarry or mine.	£ s. d.
(1) Hematite, for use in blast furnaces, mined in the counties of Cumberland, Lancashire and Glamorgan	1 6 3
(2) Hematite, lumpy, for use in steel furnaces	2 2 0
(3) Jurassic Ores, quarried or mined in the Frodingham district of Lincolnshire	3 9
(4) Jurassic Ores, quarried in Oxfordshire	3 0
(5) Jurassic Ores, quarried or mined in Leicestershire, Northamptonshire, Rutland or Lincolnshire (other than provided for under (3))	4 0
(6) Calcined Ore, quarried in Oxfordshire	7 0
(7) Calcined Ore, quarried or mined in Leicestershire, Northamptonshire, Rutland or Lincolnshire	8 6

Cinder and Scale—

	£ s. d.
(a) Produced in the United Kingdom and delivered carriage paid at any iron or steel works in England or Wales :—	
Scale with a minimum iron content of 70 per cent. (Plus or minus—as the case may be—4d. for each 1 per cent. increase or decrease—as the case may be—in the said minimum iron content.)	1 7 6
Ball Furnace Cinder containing not less than 68 per cent. iron	1 7 6
All other Cinder	1 2 6
(b) Produced and used in Scotland—f.o.t. producers' works :—	
Mill Cinder	9 0
Puddle Tap	11 0
Steel Cinder	13 6
Scrap Tap	15 6
Scale	15 6

Pig Iron—

	£ s. d.
Basic—	
(a) South Wales, N.E. Coast, Scotland, Mersey Ports, Lancashire, Cheshire, N. Wales and North Staffs.	5 1 6
(b) Sheffield	5 4 0
(c) South Staffordshire	5 6 6
Hematite.—No. 1 Mixed Nos., S. & P. over 0·03 per cent. but not exceeding 0·05 per cent. :—	
(a) Scotland, N.E. Coast and West Coast of England	6 4 6
	6 10 0
(b) Sheffield	6 16 0
(c) Birmingham	6 0 0
(d) Wales—Welsh Iron	
Foundry and Forge—	
(1) No. 3 Iron, Class 2—	
(a) Delivered Middlesbrough	5 8 0
(b) Delivered Birmingham	5 10 0
(2) Phosphorus 0·5 per cent. to 0·75 per cent.—Delivered Birmingham	5 17 6
(3) Phosphorus 0·1 per cent. to 0·5 per cent.—Delivered Birmingham	6 6 0
(4) Scotch Foundry Iron—Delivered in Scotland or England, f.o.t. producers' works	5 9 6
Cylinder and Refined Irons—	
(a) North Zone	7 16 0
(b) South Zone	7 18 6
Cold Blast Pig Iron—	
(a) South Staffordshire	10 1 0
Forging Ingots up to 0·60 per cent. C.	10 5 0

Billets, Blooms and Slabs for Re-rolling—

	£ s. d.
Basic—	
(a) Soft U.T. (100-ton lots)	8 7 6
(b) Soft T.G. up to 0·25 per cent. C. (100-ton lots)	8 12 6
(c) Hard, 0·42 per cent. to 0·60 per cent.	9 10 0
(d) Silico-manganese	12 2 6
(e) Free-cutting	10 2 6
Siemens Martin Acid—	
(a) Up to 0·25 per cent. C.	11 7 6
(b) Case Hardening	12 5 0
(c) Silico-manganese	12 2 6

Billets, Blooms and Slabs for Forging and Stamping—

	£ s. d.
(a) Basic Soft, up to 0·25 per cent. C.	10 0 0
(b) Basic Hard, 0·42 per cent. to 0·60 per cent. C.	10 7 6
(c) Acid, up to 0·25 per cent. C.	11 17 6
(d) Acid Case Hardening	12 15 0
(e) Acid Silico-manganese	12 12 6

Alloy Steels—

	Nickel 0·6–1 per cent.	Nickel-Chrome Ni 2·75–3·75 Cr 0·6–1·25 per cent.	Nickel-Chrome Molybdenum Ni 2·75–3·75 Cr 0·6–1·25 Mo 0·20–0·60, per cent.
	£ s. d.	£ s. d.	£ s. d.
Billets, 2in. up to and including 10in.	15 2 6	26 17 0	33 7 0
Stamping Bars, $\frac{3}{4}$in. diam. and up, round or equivalent sectional area	20 19 0	34 0 6	41 12 6

High Speed Steel—

	14 per cent. Tungsten Per lb.	18 per cent. Tungsten Per lb.	22 per cent. Tungsten Per lb.
	s. d.	s. d.	s. d.
Bars	3 0	3 10	4 4

Tinplate and Sheet Bars—

	£ s. d.
Not less than 25 tons of one width and quality, 9 lb. and over per ft. for bars under 8in. down to 18 lb. and over for bars 14in. and over	8 5 0

Wire Rods—

	£ s. d.
Basic.—All sizes with exception of over 7/0 gauge and 6 gauge delivered in all districts in United Kingdom except (a) Birmingham and Scotland, and (b) Southern Joint Area :—	
Soft Basic 0·08 per cent. to 0·25 per cent. C.	12 11 6
Hard Basic, 0·42 per cent. to 0·60 per cent. C.	15 14 0
Free-cutting	14 14 0
Acid.—Up to 0·85 per cent. C. all sizes with exceptions of over 7/0 gauge and 6 gauge, delivered all districts :—	
Ordinary	19 5 0

Manufactured Iron—

	Crown Iron £ s. d.	No. 3 Bars £ s. d.	No. 4 Bars £ s. d.
(a) English and Welsh delivery, usual districts	12 15 0	11 5 0	11 15 0
(b) Scottish delivery, usual districts	12 15 0	12 7 6	12 12 6
(c) Irish delivery, f.o.q., Belfast	13 7 6	11 17 6	12 7 6

Heavy Steel Products—

	Joists and Angles £ s. d.	Plates £ s. d.
Deliveries to the following Principal Districts :—		
(a) North-east Coast, Northern Joint Area, Scotland, Belfast shipyards and shipbuilders at Thorne, New Holland and Gainsborough	11 8 0	11 10 6
(b) Leeds and District, Midland area and South Wales	11 8 0	11 13 0
(c) Southern Joint Area	11 10 6	11 15 6
Medium Plates (under $\frac{1}{10}$in. thick) all deliveries :—		
Weighing 6 lb. or more per sq. ft.		12 12 6
Weighing less than 6 lb. but not less than 4·81 lb. per sq. ft.		13 2 6
Chequered Plates ($\frac{1}{4}$in. thick and upwards) delivered to :—		
(a) North-East Coast and shipbuilders at Thorne, New Holland and Gainsborough		13 0 6
(b) Northern Joint Area ; Scotland ; Leeds and District ; Midlands and South Wales ; Southern Joint Area		13 3 0

Rails—

	£ s. d.
Heavy Rails.—60 lb. per yard and over, lots of 500 tons and over ; f.o.t. Maker's works	10 3 0
Light Rails.—Light flange rails, up to and including 25 lb. per yard	12 2 6

Colliery Arches and Accessories—

	£ s. d.
4 by 2½ by 2 and 4 by 2½ by 2½, single radius with straight, horseshoe or splayed legs with one fishplate joint, complete with one pair of fishplates and the necessary bolts and nuts	12 12 6
Arches as above but *without* fishplates, bolts and nuts	12 10 0
Fishplates (for Arches) alone	18 0 0
Plain Cambered Girders, 4 by 2½ by 2 and 4 by 2½ by 2½ with minimum camber of 2in. in centre, for use underground only	12 5 0
Corrugated Straps, Roofing, or Benk Bars	11 12 6

Re-Rolled Steel Products—

	£ s. d.
Angles and Tees 4 united inches and under, and *Channels* 3in. web and under : Basis U.T.	12 6 0
Bars—Flats 5in. wide and under and *Rounds and Squares* under 3in. U.T.	12 16 0
Free-cutting Bars—Rounds	14 8 0
Hoop and Strip—hot rolled (excluding hoop and strip for Gas, Steam and Water Tubes) U.T.	13 11 0
Hoop and Strip—cold rolled basis. Hard Bright—in coils (not annealed)—1½in. to 6in. by 0·032in. and thicker	20 8 0
Products made from Basic Hard Steel—0·42 per cent. to 0·60 per cent. C.	13 16 6
Products made from Siemens Martin Acid Steel—Up to 0·25 per cent. C.	15 14 0
Spring Steel Bars— Laminated—	
(a) Basic 0·42 to 0·60 per cent. C. Water Hardening	13 16 6
(b) Acid 0·42 to 0·60 per cent. C. Water Hardening	17 7 6
Siemens Martin File Steel— Long lengths 12in. and up—	
(a) Acid	18 19 0
(b) Basic	16 6 0
Ferro-concrete Bars—delivered station or siding	12 3 6
Rivet, Bolt and Nut Bars (4 ton lots)	12 19 0

Bright Drawn Steel Bars—

	£ s. d.
(a) Mild Steel to no analysis or tests	18 3 0
(b) Tested and guaranteed, 28 tons to 32 tons tensile	19 3 0
(c) Free-cutting, B.S.S. 32, Grade 4	19 19 6

Sheets—

	£ s. d.
(a) Black, 24 G.—4 tons and over of basis quality	16 2 6
(b) Galvanised, corrugated, 24 G.—4 tons and over of basis quality	18 12 6

Tinplate—

	£ s. d.
Coke quality per basis box (I.C. 20 by 14—112 sheets—108 lb.), f.o.t. Maker's Works	1 1 6

Tubes and Pipes—

Steel Gas Tubes to B.S.S. 789—¼in. to 6in. diameter. The gross price per ft. stated in the British Standard Gas list less 61½ per cent. for sales by Makers.	
Steel Tubes to B.S.S. 534—Table 1, Class A nominal size 10in., outside diameter 10½in.	4s. 11½d. per ft.
Spun Iron Pipe 6in. diameter to B.S.S. Class B delivered station London in 4 ton lots and over	7s. 9d. per yd.

Wire—

	£ s. d.
Mild Steel Wire.—Catch weight coils 6/8 standard wire gauge :	
Hard drawn	16 10 0
Mild drawn	18 0 0
Annealed	18 0 0
Galvanised Barbed Wire.—2 or 4 point, 2 ply, 12½ gauge	24 10 0

Forgings—

Prices set out in the Related Schedules plus the percentage additions in operation at September 1st, 1939, plus a further 6 per cent.

Steel Castings—

Prices set out in the Related Schedules plus 10s. per ton.

Tyres, Axles, and Solid Wheels—

Prices set out in the Related Schedules plus 25s. per ton.

Iron Castings—

The seller's latest price ruling in 1939 before 1st September, 1939, with the addition of 10s. per ton or an equivalent percentage.

1.—Notwithstanding anything in paragraph (1) of Article 1 of the Order—

(a) Manganese Ore for the purpose of manufacturing any Chemicals, Electric Batteries, Manganese Metal, Glass or Ceramics ;

(b) Tanks and cylinders of which every sheet or plate is under $\frac{3}{16}$in. thickness ;

(c) Iron Ore for annealing, gas purification or paint manufacture ;

(d) Iron castings which have been subjected to any process other than moulding, fettling, annealing or painting ;

may until further notice be acquired without licence.

2.—Notwithstanding anything in paragraph (1) of Article 1 of the Order, any material (other than (i) pig iron and (ii) High Speed Steel containing 14 per cent. or more of Tungsten) included in the First Schedule to the Order may until further notice be acquired without licence :—

(a) by the following Government Departments, undertakings or persons (or by contractors or sub-contractors thereof) for the purposes stated in respect of them ; that is to say :—

any Government Department—for any purpose ;

any person—for the purpose of fulfilling an obligation imposed on that person by the Civil Defence Act, 1939.

any railway undertaking under the control of the Minister of Transport by virtue of any Order made under the Defence Regulations, 1939—for the purposes of that undertaking ;

any electricity generating station generating for public supply—for the purposes of that station ;

any public utility undertaking within the meaning of Regulation 100 of the Defence Regulations, 1939, and not before mentioned in this paragraph—for repair work and maintenance work for the purposes of that undertaking ;

any shipbuilder, ship-repairer, marine engineer, or marine boilermaker—for the building, repairing or equipment of any ship ; shipowner—for the repair or maintenance of any ship ;

mine or quarry undertaking—for mining or quarrying in any mine or quarry of that undertaking ;

agricultural machinery or implement maker or repairer—for making or repairing any agricultural machinery or implement for use in the United Kingdom ;

locomotive builder or repairer—for building or repairing any locomotive for use in the United Kingdom ;

wagon builder or repairer—for building or repairing any railway wagon for use in the United Kingdom ;

iron or steel works or foundry or forge—for repair or maintenance thereof ; and

producer of refractory material—for repair or maintenance of any Refractory Works owned or operated by him.

Provided that nothing in this head of this paragraph shall authorise a stockholding merchant to acquire for stock, any material included in the First Schedule to the Order ;

(b) by any person party to a contract made in writing before the 1st day of September, 1939, obliging him to deliver any material (other than (i) pig iron and (ii) High Speed Steel containing 14 per cent. or more of Tungsten) included in the First Schedule to the Order—for the purpose of delivering such material in accordance with such a contract to a Government Department, undertaking or person mentioned in head (a) of this paragraph : and also, but only after all such deliveries aforesaid shall have been made, for the purpose of delivering such material in accordance with any other such contract ;

(c) by any person making a purchase of any material (other than (i) pig iron and (ii) High Speed Steel containing 14 per cent. or more of Tungsten) included in the First Schedule to the Order from the stock actually held at the time of such purchase by a stockholding merchant—for urgent requirements ; and

(d) by any person making a purchase of any material (other than (i) pig iron and (ii) High Speed Steel containing 14 per cent. or more of Tungsten) included in the First Schedule to the Order not exceeding 10 hundredweight in quantity nor £20 in value (repeat orders not being permitted within one week)—for any purpose.

3.—This Direction shall come into force on November 1st, 1939, and may be cited as the Control of Iron and Steel (No. 4) Order, 1939, Direction (No. 1).

Dated this 31st day of October, 1939.

E. LESLIE BURGIN, Minister of Supply.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

The New Iron and Steel Prices

As announced in our last issue, the prices of practically all steel products have been increased by amounts ranging from 9s. in the case of pig iron, to £1 7s. 6d. for sheets. It will be remembered that the British Iron and Steel Federation reduced prices at the end of 1938, and that when they were reviewed in June last, it was decided to keep them at the rates then current until October 31st. In the meantime, war broke out, and these prices were established as the official maximum figures. Owing to the war conditions the latest upward movement has been notified in the form of the Control of Iron and Steel (No. 4) Order. The new Order brings under control certain descriptions of iron and steel which were previously unaffected. These include low phosphoric foundry iron 0·1 per cent. to 0·5 per cent. phosphorous the price of which is fixed at £6 6s. d/d Birmingham, and 0·5 per cent. to 0·75 per cent. phosphorous, the maximum price for which is £5 16s. 6d. d/d. There has for some time been a strong demand for this particular class of pig iron as it is extensively used by engineering firms engaged upon Government work. During the last few weeks a tightness has developed in the market and the price has shown a tendency to increase. For this reason it was expected that this description of pig iron would be brought under control. The market, however, is inclined to think that the result will be a decline in the production as the price may have been fixed too low. The market also regards the division of this iron into two categories as a rather clumsy attempt to deal with a difficult problem. Some time ago a Trade Committee sat with the idea of arranging fixed prices for low phosphoric irons but eventually decided that this could not be effectively done owing to the widely varying costs of production. Cylinder and refined irons have also been brought within the scope of the Control, as well as home iron ore, cinder, and scale, high speed steel, wire, forgings, steel castings, tyres, axles, and solid wheels, and iron castings. At the same time it is now possible to obtain without a licence tanks and cylinders in which every sheet or plate is under $\frac{1}{4}$in. in thickness; iron ore for annealing, gas purification or paint manufacture; iron castings which have been subjected to any process other than moulding, fettling, annealing, or painting. On the other hand it is necessary in every case to obtain a licence for the purchase of pig iron and high speed steel. The Order also emphasises that the purpose for which certain persons are exempted from licence is limited to material for use in the United Kingdom.

The Pig-Iron Market

The announcement of the new prices for pig iron which was made on November 1st by the Control of Iron and Steel (No. 4) Order, and came into immediate effect, provided no surprises. The maximum prices, which under present conditions must inevitably be the minimum prices, were advanced by 9s. all round, and certain descriptions of pig iron which had hitherto remained outside the scope of the Control were brought in, such as iron containing 0·1 per cent. to 0·75 per cent. phosphorus, and cylinder and refined iron. It had been expected that a maximum price would be fixed for these descriptions, but the market is inclined to fear that now this has been done it will have the effect of restricting production, particularly in the case of the former. It is said to be doubtful if iron containing certain percentages of phosphorus can be manufactured at the official figure, and for some time there has been a scarcity of low phosphoric iron. In other respects the position is practically unchanged. There is a strong demand for basic iron upon the manufacture of which most of the producers are concentrating. Hematite also is selling freely, whilst the demand for foundry iron is steadily expanding. The improvement is especially noticeable in the case of high phosphoric qualities which are chiefly used by the light castings makers. Most of the firms in this branch of the consuming industries are fully employed, and it may be expected that the demand will continue to grow. On the North-East coast consumers are being supplied from the producers' reserves and are being helped by supplies of Midland irons. As a matter of fact the Midland makers of foundry iron are experiencing a better request for their products than for many months, and the engineering firms, most of whom have a large volume of work for national purposes in hand, continue to take up good quantities of low phosphoric qualities. These have to be supplemented by supplies of hematite as there is a stringency in the former department. In Scotland the demand for foundry iron has increased so rapidly that there is a certain amount of tightness in the supply of material for prompt delivery. All the Scottish consuming trades are well employed and considerable tonnages are being used. The market for hematite remains active, but stocks of this description are held and consumers are able to obtain all the iron they need. The consumption is increasing, however, and the makers are receiving a steady flow of specifications against contracts.

The Midlands and South Wales

The announcement of the new iron and steel prices had no effect upon the market in the Midlands, since consumers are far more intent upon obtaining supplies than concerned with the price paid for them. Apart from the price movement the position in this market remains unchanged. Consumers are anxiously pressing for deliveries of finished iron and steel, and the works are struggling to meet the almost inexhaustible requirements of the market. The demand for joists sections and plates and all descriptions of structural steel, has reached huge proportions, and although every department of the works and all possible plant has been brought into operation, there is a tendency for delivery dates to lengthen and for the makers to get into arrears against contract dates. Preference has to be given to the requirements of Government Departments, and to those consumers busy upon Government work who urgently need material. As a consequence, users with less claim to priority have to wait, sometimes longer than is convenient. Recently a vigorous request has developed from the agricultural machinery makers, and for material for public utility purposes. Stringent conditions still obtain in the semi-finished department. The request for billets is insistent, and in spite of rationing and other methods adopted by the Control, complaints are rife that operations cannot be fully maintained at some of the re-rolling works. The general view is that this tightness is only temporary, and that supplies from abroad will be arranged. The re-rollers, however, are producing large tonnages of bars, strip, and small sections, and have order books that will keep them well employed for weeks to come. The plate mills are busy and the makers have a large supply of orders in hand. In the Lancashire market, busy conditions prevail and consumers are searching the market to find works able to give prompt delivery. So large a production is taken up by users having priority claims that other classes have difficulty in obtaining their requirements. The tank- and boiler-making firms are well employed, and provide a big outlet for plates and other steel materials. The demand for steel bars of all kinds is maintained, and there is a good request for alloy and special steel.

Scotland and the North

The Scottish iron and steel works are making record outputs, although as no statistics are available it is impossible to say what is the actual tonnage. It is currently reported, however, that the production in September exceeded previous levels. A large proportion is on Government account, but it is realised that the export trade cannot be neglected and a comparatively small amount of steel material is being reserved for overseas customers. It is suggested that more business has been done direct between works and foreign buyers than is usually the case, and export merchants who find it difficult to place orders are beginning to grumble. A certain amount of steel has also been available lately for work of a commercial character. Generally speaking, deliveries on the latter account are fairly well maintained although naturally the necessity of giving preference to Government departments and other privileged consumers forces ordinary business into the background. The heavy requirements of the shipyards continue to increase rather than the reverse, and so far as can be judged this industry will need exceptionally large quantities of shipbuilding material for a long time. The outlook so far as the constructional engineers are concerned is also satisfactory and most firms have contracts in hand which will keep them busily employed well into next year. It might have been expected that firms with contracts to place would wait until the new prices were published at the end of October, but apparently the need to obtain material outweighed all other considerations, and all business for some time has been booked on the terms of prices ruling at the date of delivery. Not only is there great pressure to secure supplies of the larger sizes of sections, but the smaller descriptions made by the re-rollers are also in active demand. The latter industry would be able to turn out greater quantities if it were assured of larger supplies of billets. It is generally believed that this shortage is temporary and great efforts are being made to overcome any deficiencies. The plate makers are experiencing considerable pressure from the boiler and tank makers and other important users, and it is now not easy to place orders except for somewhat extended delivery. Consumers in the Lancashire area are using large quantities of steel and so well are the steelworks provided with orders that consumers have to search the market thoroughly to obtain anything like near delivery. There is a strong request for steel forgings, both heavy and light, and the operations of the producers are calling for large supplies of billets and blooms. The demand for bright steel bars is maintained and some stringency is felt in this department. The demand for small sizes of structural steel keeps the re-rolling works well employed and there is a particularly active business passing in reinforcing bars.

Copper and Tin

The copper market is in as favourable a position as is possible under war-time regulations. All the consuming industries without exception are exceedingly busy on work for the Government, and the consumption of copper is at a high rate. Nevertheless, there is little complaint amongst consumers regarding their deliveries, and the Non-Ferrous Metal Control seems to have the situation well in hand. Negotiations are understood to be proceeding with the object of permitting merchants to charge a commission. According to reports from Canada, the Government's big deal with the Canadian copper manufacturers was on the basis of about 10½ cents per lb., which is approximately the same as the official maximum price of £51 per ton. In the United States rather quieter conditions have developed, and it would seem that the big consumers there have covered themselves for some time. On the other hand the producers are so well sold that they are not pressing to obtain business. The export price of copper in America is 12.90 cents f.a.s. which is well above the American domestic price of 12.50 cents. The world quotation, therefore, has left behind both the American producers' domestic price and the British fixed price. There is apparently a movement abroad as well as in this country to expand the refinery production, and the Union Miniere du Haut Katanga has restarted two copper refining furnaces in the Congo which have not been working since 1932. . . . Although the tin market remains more free from control than the other non-ferrous metals there is a definite stringency in the prompt position due to the large quantities of tin which have been exported. The action of the Government, however, in cancelling tin export licences and of the International Tin Committee in raising the quota for the current quarter to 100 per cent., is a move in the right direction, and should do much to rectify the position. It is understood that the Nigerian mines during the past few weeks have shipped tonnages representing two or three months' output. The International Tin Committee has also announced that the quota for the first quarter of 1940 will not be less than 60 per cent., but the general impression in the market is that the quota will remain for some time at 100 per cent. According to Mr. W. H. Gartsen's figures the total visible supply at the end of October was 30,695 tons, compared with 21,708 tons at the end of September. The supplies during the month totalled 19,022 tons, compared with 10,006 tons at the end of September, whilst the deliveries in October were 10,035 tons against 8633 in the previous month.

Lead and Spelter

The situation in the lead market is fairly satisfactory since, in spite of the heavy consumption, users appear to be getting their metal without difficulty. Some merchants complain that they cannot obtain prompt metal and the position for this delivery seems to be rather irregular. The cable makers and other large consumers are understood to have covered their requirements for a long time ahead, but there is in addition to the demand for lead for work of national importance a steady call from users who have lesser priority claims and have to wait for prolonged delivery. The Canadian output of lead in July totalled 15,874 short tons, against 16,375 tons in June and 19,363 tons in July, 1938, the total production for the first seven months of this year being 108,873 tons. Canadian exports of lead fell from 19,960 tons in June to 14,450 tons in July. . . . Whilst an active trade is passing in spelter it is difficult to give details of the position in the absence of any dealings on the London Metal Exchange. Supplies appear adequate to meet all requirements, and consumers are receiving regular deliveries. Practically all the large consuming concerns are employed almost to capacity upon work of national importance. Merchants are still without any authority to charge commission, and a considerable amount of the business passing is done direct with the Control, although the latter has recommended that consumers should obtain their metal through their normal channels of supply. There is a stringency in the market for zinc sheets, and in the House of Commons this week the President of the Board of Trade was asked if he was aware that thin gauge sheets were not obtainable for domestic and export trade from the United States, and whether he would consider withdrawing the 15 per cent. import duty for the time being. The reply was that interested companies had submitted representations which were then under consideration.

Non-Ferrous Metal Trades Dissatisfaction

On several occasions we have referred to the discontent prevailing in the non-ferrous metal trades at the methods of control adopted by the Ministry of Supply. The arrangements for liquidating the open positions on the Metal Exchange, following the outbreak of war, were completed on October 31st, but there seems to be little likelihood that the markets for copper, lead, and spelter will be reopened. On November 3rd, a meeting of prominent members of the London Metal Exchange was held, at which the following resolution was passed: "That the sub-committee should continue its efforts to obtain from H.M. Government assurances that the control of non-ferrous metals should be vested in a committee representative of, and experienced in, all branches of the trade so as to further the national interest and avoid the creation of a monopoly."

Non-Ferrous Metal Average Prices

The London Metal Exchange average prices for October do not of course show any change from those published at the end of September, except in the case of standard tin. During October copper, lead, and spelter were under strict control at the established maximum prices. In the case of cash tin the quotation showed an advance from the average of £229 8s. 9d. in September to £229 19s. 5d. in October, whilst for three months the average rose from £228 7s. 5d. to £229 15s. 8d. In October the average settlement price showed an increase to £229 19s. 9d. from the September figure of £229 9s. 8d. The following are the official average quotations for October :—

Standard Copper ...	Cash (mean)	£46	0	0
	3 Months (mean) ...	£46	0	0
	Settlement	—		
Electrolytic Copper (Mean)...		£51	0	0
Ditto Ditto	Wire Bars...	£51	0	0
B.S. Copper (mean) c.i.f.		£49	10	0
Standard Tin	Cash (mean)	£229	19	$5\frac{13}{32}$
	3 Months (mean) ...	£229	15	$8\frac{7}{11}$
	Settlement	£229	19	$9\frac{4}{11}$
Lead	For shipment the current month (mean)	£16	12	6
	For shipment the third following month (mean)	£16	12	6
	Mean	£16	12	6
	Settlement	—		
Spelter	For shipment the current month (mean)	£15	0	0
	For shipment the third following month (mean)	£15	0	0
	Mean	£15	0	0
	Settlement	—		

French Engineering Notes

(From our own Correspondent in Paris)

Decentralising Industry

Armament production works in Alsace and adjoining areas are being removed to the interior of the country with the aid of the military authorities who supply men to dismantle machines and plants, as well as railway trucks to carry the whole of the installations to where the Government has made free grants of land for the erection of new works. This is done without cost to manufacturers. On a less drastic scale there is a voluntary migration of works and factories from other dangerous areas. In these cases approval of sites selected must be obtained from the military authorities, presumably to be assured that they are beyond the range of attack on military objectives. Air warfare has changed entirely the conditions under which industrial production may be carried on with safety. So long as there is no permanent security, works and factories tend to be decentralised in a manner to reduce risks to a minimum, but limitations are imposed on a spreading of industry by the facilities offered for production, such as supplies of raw materials, energy, and labour, as well as distribution under economical conditions. In France, the main industrial centres are in the northern and eastern departments, in the Paris area, and in the region of the Loire. Hydro-electric supplies from the Alps, Massif Central, and the Pyrenees, and improvements to inland water transport, have extended areas in which many industries can be carried on, so that the problem of decentralisation offers increasing possibilities of solution. The first big move was made by the Government when the nationalisation of aircraft production was followed by the installation of factories by seven national companies in different parts of the country. They are capable of practically unlimited extension. Decentralisation is encouraged not only by a desire for security under conditions of danger from the air, but also by reason of social interests that led to a migration of works from congested areas at a time when there appeared to be no urgent necessity for protection from dangers that had not become realities. Experience of the labour revolution showed that congested areas were being disorganised by Communist activities. Such congestion offers conveniences through the grouping of suppliers and manufacturers, as well as by the dependence of so many works and factories upon each other, and the organised facilities for distribution, but a lowering of the moral standard of workers through extremist propaganda destroyed, for the time being, all these advantages of production. The danger is now past with the elimination of Communist elements. Nevertheless, it revealed to employers the importance of the social aspect of industrial decentralisation. They sought to get away from surroundings favourable to mass agitation and transfer works to other centres where, in many cases, they would have to provide housing for their men and their families and social services that would create self-contained communities and attach workers permanently to their employment. This was done by some big firms who had reason to be satisfied with results. Unfortunately, the burden of these social services, in addition to that of compulsory services, falls so heavily on employers in these times of price control and profit limitation, that the whole system must be revised if it is to be continued and extended. Social plans can only be based upon the freedom of employers to carry on their business normally. During the war a large measure of industrial decentralisation is a matter of national emergency. What will happen after the war depends upon subsequent reactions.

Civil Aviation

Air services have been resumed after the interruption caused by mobilising and getting the army into position at the front, where it was supposed that skilful and experienced pilots on the air lines would have been required. The war, however, is to be carried on without sacrificing national air services. Communication by air must be kept up with the colonies in the interests of national defence and national economy, for the African colonies contribute largely to the country's man power, and if air services were withdrawn in present circumstances it would mean a serious loss of prestige. It is also intended to continue the programme for developing civil aviation, including the North Atlantic service, preparations for which have not been suspended. It is argued that there should be no slackening of effort to extend and improve air services at a time when their value is so largely enhanced by the risks of sea navigation. There are now three daily services between Paris and London, Paris and Algiers, and Tunis and Casablanca; three services a week between Marseilles and Ajaccio; and weekly services between Algiers and Brazzaville, Marseilles and Dakar and South America, Dakar and Point-Noire, Marseilles and Beyrouth, and the line from Paris to Hong Kong by way of Alexandria, Bagdad, Calcutta, Saignon, and Hanoi. Passengers are carried on all lines except the one across the South Altantic between Dakar and Natal, in Brazil.

Labour Relations

The change in the relations between employers and workers is reflected in the final conclusion of a case that arose in 1937 over the right of employers to exact the full forty hours when the working week was shortened by a holiday. This meant working on a Saturday, which labour unions refused to sanction. The case in question was a claim for damages brought against the Union of Metal Workers by the Chantiers de la Loire and the Chantiers de Penhoët for preventing men from working in the shipyards at Saint-Nazaire on a Saturday following a day's holiday. Damages amounting to £2280 were awarded to the Saint-Nazaire shipbuilding companies. An appeal by the Union of Metal Workers was rejected in 1938. The union then endeavoured in vain to obtain relief from these crushing damages. The Boards of Directors of the two companies, whose shipyards work in association, have now informed the union that the damages will be remitted as proof of their desire to forget the past at a time when all are working together for the country's defence.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

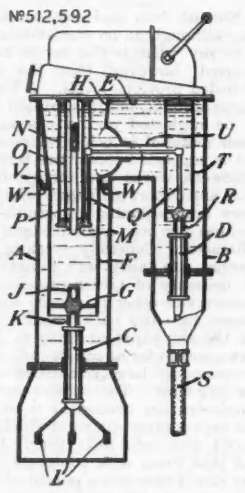
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

SWITCHGEAR

512,592. July 18th, 1938.—Circuit-breakers for High Voltage, Hendrik Arend Hidde Nijland, of 23, Rijksweg Oost, Laren (N.H.), The Netherlands.

According to the invention the contact make and break element is surrounded by a casing of insulating material, which completely isolates the space in which the switching operation is carried out from the compartment which the leading-in conductors enter, so that no arc products can be thrown into the latter compartment and spoil the insulation therein. The tank consists of two tubular casings A and B communicating with one another at their top ends and having the insulators for the leading-in conductors C and D mounted in their respective bottoms. The tank is filled with mineral oil E. The contact make and break element is secured to the cover of the tank and immersed in the oil. The contact make and break element is accommodated in a tube F of insulating material, which is closed at its lower end by a plate G. Mounted on the top end of tube F is a funnel-shaped metal member H. Secured to the plate G is a fixed switch contact J and a contact sleeve K, directly electrically connected thereto. The contact sleeve K engages the plug-shaped top end of the leading-in conductor, the bottom end of which is connected to one of the three distributing busbars L mounted in a separate casing. Within the tube F, a second fixed switch contact M is mounted some distance above the fixed switch contact J, the contact M being



secured to the cover by means of insulators N and O. The switch contacts J and M co-operate with a switching conductor P adapted to be axially moved by an operating mechanism. The switching contact M is conductively connected, through a bridging conductor Q, to a second contact sleeve R, which engages the plug-shaped top end of the leading-in conductor D, the lower end of which is connected to a cable S. The contact sleeve R is supported by a plate, which closes the lower end of a tubular insulator T secured to the cover. The horizontal portion of the bridging conductor Q is surrounded by a tube of insulating material, which is passed through the wall of the funnel-shaped metal member H. The parts F, H, T, and U are filled with mineral oil. The oil, in which the switching operation is carried out, is entirely separated from the oil E in the tank, which serves to insulate the live parts of the circuit-breaker from the metal walls of the tank. It is not necessary for the insulating fluids to be of the same composition. Also, the invention is not restricted to the use of liquid insulating materials only. If the insulating fluid E is a liquid, its incompressibility can be used to reinforce the tube F. For that purpose, the casing of the illustrated circuit-breaker is closed by a partition V provided with vents W, which are so small as to prevent liquid passing during the switching explosion (1/200 sec.). Since the partition V is mounted below the level of the liquid E, the lower part of the casing will always be entirely filled with liquid, which is essential with a view to the purpose aimed at.—*July 18th*, 1939.

METALLURGY

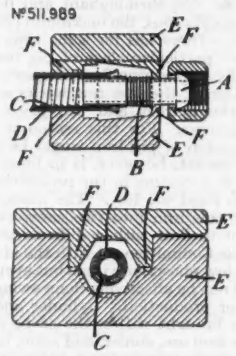
512,538. *July 8th*, 1938.—Improvements in Articles of Aluminium or Aluminium Alloys, Ferranti, Ltd., Hollinwood, Lancaster, George Ingle Finch, Imperial College of Science and Technology, Prince Consort Road, South Kensington, London, S.W.7, Jack Dawson and Thomas Leslie Houghton, both of the Company's address.

The invention comprises a method of coating the surface of an article of aluminium or an aluminium alloy, *e.g.* an engine piston, with an amorphous layer of complex aluminium magnesium oxide which consists in electrolytically depositing magnesium on the surface of the body, heating to effect diffusion, and subjecting the surface layer to anodic treatment. In carrying the invention into effect, according to one example as applied to a piston for an internal combustion engine, the piston is made of pure aluminium machined to the desired size. The piston is connected as the cathode in a bath of molten anhydrous salts, the bath being composed of magnesium chloride 40 per cent. to 44 per cent., sodium chloride 22 per cent. to 26 per cent., potassium chloride 30 per cent. to 34 per cent. and calcium fluoride 0 per cent. to 2 per cent. The anode is formed of magnesium. Electrolysis is carried out for 10 to 30 minutes at about 12 amperes per square foot current density, the bath being maintained at a temperature of about 500 deg. Cent. The piston is then removed and quenched and again heated at a temperature of about 450 deg. Cent. for an hour or longer, after which it is quenched once more and then machined to its original dimensions. The electrolytic process causes the deposition of a magnesium layer on the surface of the piston and the heat treatment causes the magnesium to diffuse into the aluminium to form a layer of aluminium/magnesium alloy. The piston is subjected to anodic treatment which increases the amorphous layer of complex aluminium/magnesium oxide which prevails throughout the useful life of the piston despite "running-in" operations and working under conditions of high duty. Suitable alloys to compose the surface layer contain from about one part to one-fifth part by weight of magnesium to one part by weight of aluminium.—*September 19th*, 1939.

MISCELLANEOUS

511,989. April 2nd, 1938.—Joining Pipes and Tubes to other Elements, The Power Flexible Tubing Company, Limited, Derby Works, Finsbury Park, London, N.4, England, and Charles Herbert Jeffreys, of the Company's address.

A method is described of joining together a union, spigot, or nozzle element, and at least one flexible tube. It consists in moulding synthetic resin or other thermo-setting material about the end of the pipe or tube and the element to be connected to it. A preferred method of making a joint, according to the invention, is described with reference to the accompanying drawing. The nipple element A presents a conoidal enlargement on a tubular shank, the middle portion of which has a number of circumferential ridges B. A nut engages a shoulder behind the nipple on the end of the element. The end of the tubular shank is inserted in the end of a flexible tube C, and the end of a rubber tube D covering the tube C is expanded or splayed, which exposes the helically grooved surface of the flexible tube



end. The tube and the nipple element thus assembled are placed in a two-part mould, the dies EE of which present complementary part flanges FF which firmly engage the tube and similar part flanges which firmly engage the nipple element to locate them coaxially when the dies are pushed together. A chamber within the assembled mould extends axially to include the ridges on the nipple element and the expanded portion of the covering. Synthetic resinous, thermo-setting material is introduced into the die chamber, heat and/or pressure being applied to cause the material to set or harden. The tube C and the nipple element are thereby permanently jointed together, the security of the joint being enhanced by the bonding of the resinous material with the expanded or splayed end of the covering, with the exposed convolutions of the end of the tube, and with the ridges on the nipple element. The hexagonal portion of the moulded substance enables the tube to be held against rotation during manipulation of the flanged nut.—*August 28th*, 1939.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Bradford Engineering Society

Monday, Nov. 13th.—Technical College, Bradford. "Scale Models in Engineering," J. G. Jagger. 7.30 p.m.

Institution of Civil Engineers

Tuesday, Nov. 21st.—Great George Street, Westminster, S.W.1. Ordinary meeting for the election of new members. 3 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, November 21st.—39, Elmbank Crescent, Glasgow. "Characteristics of Silent Propellers," A. W. Davis. 6.30 p.m.

Iron and Steel Institute

Thursday, Nov. 23rd.—4, Grosvenor Gardens, S.W.1. Statutory Autumn Meeting. 3.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Friday, Nov. 10th.—Mining Institute, Newcastle-upon-Tyne. "Welding as an Integral Part of Design," B. P. Haigh. 5.30 p.m.

Junior Institution of Engineers

Saturday, Nov. 11th.—39, Victoria Street, Westminster, S.W.1. Annual General Meeting. 1.30 p.m.

Friday, Nov. 24th.—39, Victoria Street, Westminster, S.W.1. "The Revival of the Gas Producer," K. W. Willans. 6.30 p.m.

Royal Institution of Great Britain

To-day, Nov. 10th.—21, Albemarle Street, W.1. "Infra-Red Spectra and the Structure of Molecules," W. H. J. Childs and H. A. Jahn. 2.30 p.m.

Royal Society of Arts

Wednesday, Nov. 15th.—John Street, Adelphi, W.C.2. "The Charcoal-Iron Industry," H. Gwynn Jones. 2.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS

The Broadway Engineering Company, Ltd., Carlisle Road, Hendon, London, N.W.9, has been appointed sole agent in this country for The Fray Machine and Tool Company, Glendale, California, manufacturers of a new all-angle back-geared milling attachment designed to convert any milling machine into a vertical milling machine.

The Zinc Development Association informs us that it is continuing its activities during the war period. Its new address is:—Zinc Development Association, Lincoln Buildings, 15, Turl Street, Oxford. In addition to providing its normal technical services, it will be pleased to give relevant advice and information on official procedure and regulations concerning the supply and use of zinc during the war period.